Rangeland Technology Equipment Council

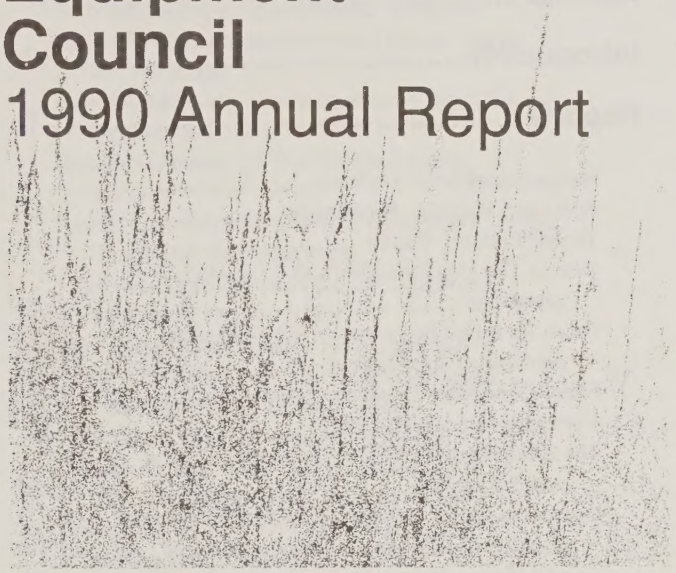
1990 Annual Report

Technology & Development Program

January 1991
9122-2805-MTDC

Rangeland Technology Equipment Council

1990 Annual Report



Participants:

U.S. Department of Agriculture
U.S. Department of the Interior
State and County Agencies
Industry Representatives
Educational Institutions
Ranchers
Foreign Countries

January 1991
9122-2805-MTDC

Published by:

USDA Forest Service
Technology & Development Center
Bldg.1, Fort Missoula
Missoula, Montana 59801

Contents

Contents

Contents

Contents

Workgroups

Steve Monsen, Chairman, RTEC
USDA Forest Service
Shrub Sciences Laboratory
735 N. 500 E.
Provo, UT 84664

Those interested in participating in the activities of a workgroup should write or call the workgroup chairman.

Information and Publications

Dick Hallman, Chairman, FS
Missoula Technology & Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801

Plant Materials

Wendall Oaks, Chairman, SCS
Plant Materials Center
1036 Miller St
Los Lunas, NM 87031

Fire

Phil Range, Chairman, BLM
Boise Interagency Fire Center
3905 Vista Ave
Boise, ID 83705

Seeding and Planting

Harold Wiedemann, Chairman
Texas Agricultural Experiment Station
Box 2658
Vernon, TX 76384

Seedbed Ecology

(Vacant)

Structures

(Vacant)

Weeds and Weed Management

(Vacant)

Drawings

Single copies of drawings are available from the Technology and Development Centers. Most are available without charge. Write to:

USDA Forest Service
Technology and Development Center
Building 1, Fort Missoula
Missoula, Montana 59801

USDA Forest Service
Technology and Development center
444 East Bonita Avenue
San Dimas, California 91773

Drawings From MTDC

B.C. Drag Chain Scarifier, No. 790

Disk Chain Implement, No. 757

Optional Dryland Sodder Bucket, No. 682

Sprig Spreader, No. 652

Sprig Harvester, No. 651

Dryland Sodder, No. 631

Tubling Planter, No. 628

Basin Blade, No. 619

Horse Trap Trigger, No. 618

Mulch Spreader, No. 611

Tree Transport Container, No. 604

Tree Transplant Trailer, NO. 6702

Modified Hodder Gouger, No. 583

Dixie Sager and Modified Ely Chain, No. 568

Drawings at SDTDC

Pipe Harrow, RM1-01 and 02

Brushland Plow, RM2-01 to 22

Oregon Press Seeder Assembly (not complete), RM 19-01 to 07

Plastic Pipe Layer Assembly, RM21-01-03

Reel for Laying Plastic Pipe, RM 14-01

Contour Furrowers, RM25-01-14

Rangeland Drill Deep Furrowing Arms, RM 26-46 to 61

Steep-Slope Seeder, RM 33-01-18

Demonstration Interseeder for Rocky and Brushy Areas, RM 35-01-09

Agenda

Reno, Nevada
Saturday, February 10, 1990

Introductory Remarks	Gerald Henke, Chairman Range Technology Equipment Council
Information and Publications	Dick Hallman USDA Forest Service MTDC Bldg. 1, Ft Missoula Missoula, MT 59801
Hurricane Hugo	Dan W. McKenzie USDA Forest Service SDTDC 444 E. Bonita Ave San Dimas, CA 91773
Arid Land Seeding	Harold T. Wiedemann Texas Agricultural Exp. Sta P.O. Box 1658 Vernon, TX 76384
Plant Materials	Wendall Oaks USDA Soil Conservation Service Plant Materials Center 1036 Miller St SW Los Lunas, NM 87031
Noxious Weed Control	J.C. Gibbs USDA Soil Conservation Service Plant Materials Center 3244 Elder St, Room 124 Boise, ID 83705
Pitter—Contour Furrower	Joseph Fraser USDA Soil Conservation Service Plant Materials Center 1036 Miller St SW Los Lunas, NM 87031
Acorn Planter	Jim Truax 3609 Vera Cruz Avenue Minneapolis, MN 55422
Rangeland Drill Improvement	John Laird Laird Welding and Mfg. Works P.O. Box 1053 Merced, CA 95341

Sunday, February 11, 1990

Reorganization of Vegetative Rehabilitation and Equipment Workshop (VREW)	Gerald Henke, Chairman, Range Technology Equipment Council
Introductory Remarks	Dan W. McKenzie USDA Forest Service SDTDC 444 E Bonita Ave San Dimas, CA 91773
Timber Bridges	Lola Mason USDA Forest Service SDTDC 444 E Bonita Ave San Dimas, CA 91773
Central Tire Inflation—What's In It For Me?	Paul Greenfield USDA Forest Service SDTDC 444 E Bonita Ave San Dimas, CA 91773
Lightweight Chains	James N. Davis USDA Forest Service Shrub Sciences Laboratory 735 N 500 E Provo, UT 84606
Introduction to Fire	Phil Range Bureau of Land Management Boise Interagency Fire Center 3905 Vista Ave Boise, ID 83704
Foam As A Tool	Ronald R. Rochna USDI Bureau of Land Management Boise Interagency Fire Center 3905 Vista Ave Boise, ID 83705
Foam Generating Equipment	Dan W. McKenzie USDA Forest Service SDTDC 444 E Bonita Ave San Dimas, CA 91773
The Effectiveness of Class A Foams	Ronald R. Rochna USDI Bureau of Land Management Boise Interagency Fire Center 3095 Vista Ave Boise, ID 83705
Using The Global Positioning System For Field Location In Forestry Operations	Richard G. Hallman USDA Forest Service MTDC Bldg. 1, Fort Missoula Missoula, MT 59801
Use of Video–Camcorder To Document Sagegrouse Use of Sagebrush	Fred J. Wagstaff USDA Forest Service Shrub Sciences Laboratory Provo, UT 84606
Concluding Remarks	Gerald Henke, Chairman VREW
Business Meeting	

Introduction

The Vegetative Rehabilitation and Equipment Workshop was an informal group of range specialists who were concerned with developing and testing equipment and serving as a clearinghouse of information for land managers. The effort to adapt or develop equipment suitable for range seeding began in 1945. The original organization was called the Range Seeding Equipment Committee. In 1975 the group became the Vegetative Rehabilitation & Equipment Workshop (VREW) to better reflect the expanded interests and membership. The USDA Forest Service, the Bureau of Land Management, the Soil Conservation Service, the Bureau of Indian Affairs, as well as State agencies, universities, manufacturers, energy companies, seed suppliers, ranchers, and consultants met to consider harvesting brush and grass seed, evaluate aerial ignition techniques, develop equipment for reclaiming strip-mined land and revegetating disturbed areas in arid climates. The goal of establishing permanent, diverse vegetative cover remained the prime concern of VREW through 1989.

In 1990 the growing role of State and Private resource agencies led to a broader charter for the group. The Rangeland Technology and Equipment Council (RTEC) has been formed to incorporate all federal , state, and private range land managers. The Council will focus on high technology techniques as well as traditional equipment development for solving management problems.

This year's RTEC annual report presents a selection of equipment and techniques reported at the Reno meeting by 1990 speakers. We have also included a synopsis of articles representing the body of work accomplished by the Vegetative Rehabilitation and Equipment Workshop for 1980 through 1989.

Range Handbooks

Richard G. Hallman, Program Leader, USDA Forest Service, Missoula Technology and Development Center Missoula, Montana

Three range handbooks recently published by the Missoula Technology and Development Center are now available from the Society of Range Management in Denver. These structural improvement handbooks consolidate numerous handbooks now scattered through many federal agencies into three volumes: *Fences; Facilities for Handling, Sheltering, and Trailing Livestock;* and *Facilities for Watering Livestock and Wildlife.* Each volume describes components, uses, advantages and disadvantages, safety and environmental concerns, suggestions for redesign or new concepts for future development. Costs are included where possible. Pertinent books and articles are included in a bibliography in each volume.

Facilities for Handling, Sheltering, and Trailing Livestock, 8724-2809, September 1987. This publication discusses facilities for wildland horse, sheep, and cattle management. The book describes corral systems (pens, alleyways, fences, and gates); restraining devices (loading, working, and squeeze chutes, cradles, and tables); and miscellaneous facilities such as dipping vats, spray pens, dusting alleys, back rubbers, and scales. Sheltering facilities include sheds, shade shelters, windbrakes, and feeding and watering devices. The section on trailing livestock describes driveways and driftways, low-water crossings, culverts, corduroy log crossings, and bridges. Facilities discussed may apply to wildlife as well as domestic animals, but specific information on wildlife management is not included.

Fences (8824-2803, July 1988). This handbook consolidates information on planning, building, and maintaining fences. Information is included on: gathering site information; locating the fence; choosing a fence design; clearing the right-of-way; laying out the fence; and safety concerns. It describes components including braces and posts, brace designs, gates and materials and tools necessary to build a fence. Detailed descriptions of electric, wire, and wood fences are discussed.

Facilities for Watering Livestock and Wildlife, MTDC 89-1, January 1989. This volume gives an overview of basic concepts, techniques, and equipment used to provide water for livestock and wildlife. These facilities are improvements that collect, transport, store, or provide access to water. Collecting water discusses wells, pumps, windmills, dams, and reservoirs. Transporting water includes information on pumps and piping. Water storage describes reservoirs and storage tanks. The section dealing with access to water facilities describes methods of allowing wildlife and livestock to water without damaging the storage facility.

These volumes can be ordered from:

Society of Range Management
1839 York Street
Denver, Colorado 80206

There is a charge for each volume:

Fences, $10
Facilities for Watering Livestock and Wildlife, $6
Facilities for Handling, Sheltering, and Trailing Livestock, $5

Range Handbooks

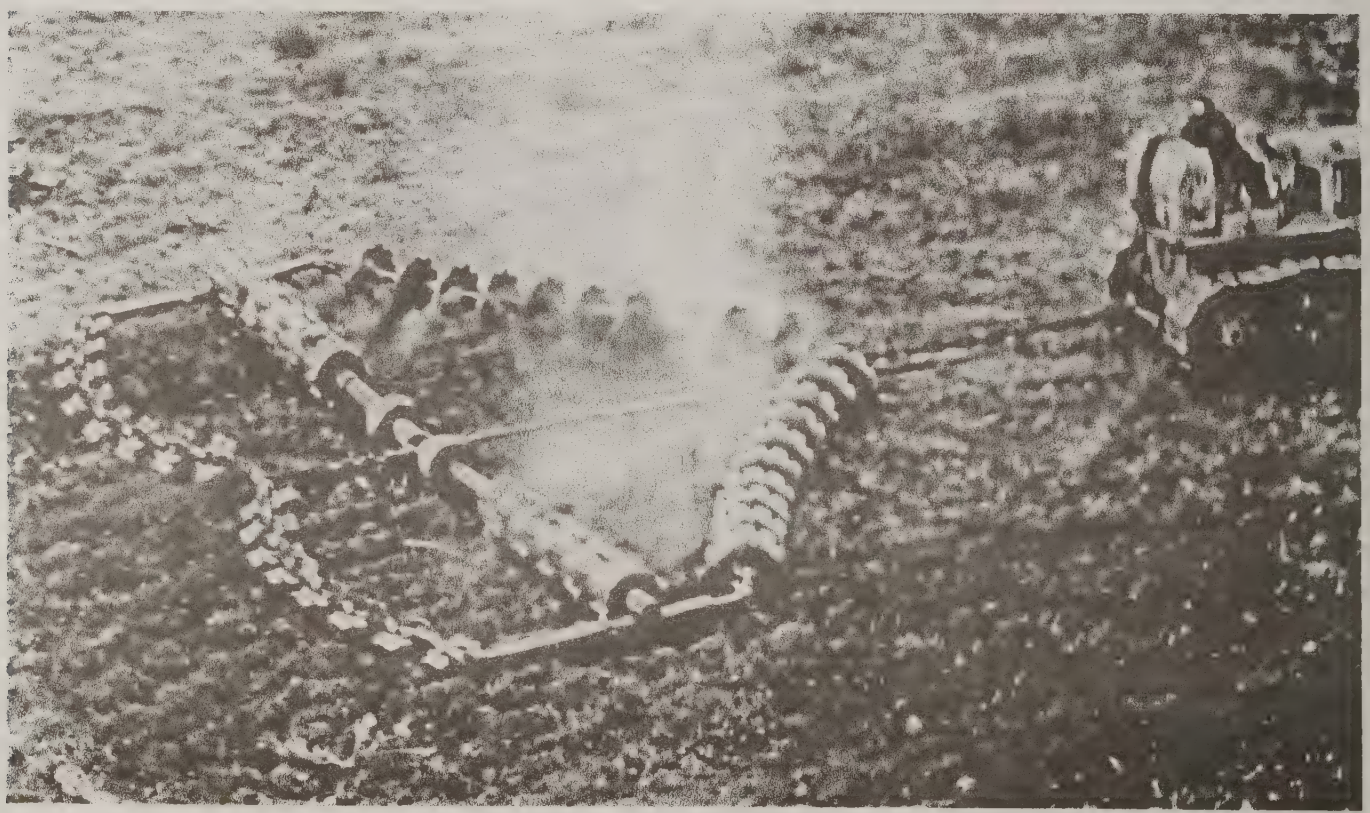
Arid Land Seeding

Harold T. Wiedemann, Professor of Agricultural Engineering, Texas Agricultural Experiment Station Vernon, Texas

A new tool is under development that forms small basins about 4-inches deep on flat-tilled land to reduce runoff and enhance seeded grass establishment on rangeland. The broadcast diker uses special shaped blades welded to a large anchor chain. As it is pulled over tilled land, the chain rotates and the blades leave a broadcast pattern of 20,000, diamond-shaped basins/acre.

For rangeland seedbed preparation, the chain diker is well suited to be pulled behind a disk-chain. This combination provides tillage, land smoothing and basin formation all in one pass on debris littered land. Attaching the diking chain to the disk chain improved the disking action of the unit significantly. On rootplowed, clay loam soil, which was aerially seeded following diking, there was a three-fold increase in seeded grass densities compared to non-diked treatments (1988). In our 1989 study, there was no difference in grass densities between diked/non-diked treatment because 9.2 inches of rainfall during the 60 days following seeding masked any seedbed differences. This new tool appears very promising for rangeland seeding especially when moisture is in short supply.

In a wheat production study (1988-89), diking increased grain yield by 11 percent and reduced runoff by 25 percent during the fallow season (1989) compared to non-diked treatments (less than 1 percent slope). Power requirements for the cropland dikers were 0.8 to 0.9 horsepower per foot of width when pulled at 5.0 mph. The chain diker is designed to be pulled behind a primary tillage tool, eg. chisel plow or disk. They cost approximately $350/foot and can be built in widths up to 90 feet. Additional information is available.



Disk Chain Diker

Timber Bridges

Lola Mason, Engineer, San Dimas Technology and Development Center, San Dimas, California

Introduction

Many times, stream crossings need to be made in remote areas. Culverts are typically used as an inexpensive means for making crossings yet there are times when an alternative is needed. Timber bridges can be competitive with concrete and steel bridges on short spans of less than 50 feet. They are typically less expensive and take little training to build. If treated properly, a timber bridge can have a long, useful life with very little maintenance. Timber has been used as a structural material since the beginning of man. In this country, there are many timber bridges that are still in place and serviceable after 100 years. Timber is a renewable material that is very strong compared to its light weight, making it easy to work with. Timber bridge construction can be performed in any type of weather condition once the substructure is in place. There are three types of timber bridge decks: nail-laminated; glue-laminated; and stress-laminated.

Transverse nail-laminated decks on longitudinal stringers were the original design for timber bridges. Lumber of 2-inch nominal dimension are through-nailed and then toe-nailed to the stringers. There is little reflection due to the closely spaced stringers. This type of design is not used as much anymore because the lumber making up the deck would delaminate. The nails loosen due to traffic deflection and cyclic swelling and shrinking of the wood from moisture variations. The deck would no longer be a waterproof shield and the excess moisture would promote the decay of the stringers and other timber members of the bridge.

Stress-Laminated Timber Deck

Transverse glue-laminated decks on longitudinal stringers or longitudinal glue-laminated decks have replaced the nail-laminated design. Lumber of 1.5 inches to 2 inches nominal dimensions are glued together using a waterproof, high strength glue. Glue-laminated timber is higher in strength because deficiencies in the lumber can be eliminated or spread out so that there are no major weak points. The panels can be any length and are no greater than 4 feet wide. The panels are then connected using dowels. The problem designers are trying to solve is that the dowel holes cannot be too tight or else the panels will not go together easily. Yet, if they are not tight enough, traffic will deflect the panels separately causing cracks in the asphalt surfacing which will lead to moisture traveling through the deck to the timber below.

Longitudinal stress-laminated decks are a new design. Ontario, Canada, began using this design to rehabilitate existing nail-laminated bridges. Then they began using it for new bridge designs as well. Lumber of 2-inch to 4-inch nominal dimension are drilled with holes along the center spaced at 4-foot intervals. Post-tensioning rods used in prestress concrete are placed through the holes and then through steel plates on both sides. A jack is used to pull the rod to a predetermined tension and nuts are used to keep that tension in the rod. The rods through the plates literally squeeze the lumber together so tightly that the entire deck acts as a solid plate of wood. This design is so new that it is not yet known how long the rods will hold the required amount of tension. At this time, experimental bridges of this design are in place and being monitored and the design is being introduced to AASHTO for acceptance as a valid bridge design.

Construction and Cost

For all three types of decks, construction is relatively easy. Some carpentry knowledge would be needed for the nail-laminated deck and it would take some time nailing all the lumber together. No heavy equipment would be needed for the deck. A small crane or fork lift would be needed for the glue-laminated deck because the 4-foot wide panels are prefabricated and shaped to the site as individual panels. Construction is simple due to panels being set in place and connected by dowels. The most difficult part is lining up the panels so the dowels can be inserted. A crane is typically used to set the stress-laminated deck into place. The deck can either be prefabricated and shipped to the site as panels or the individual lumber can be shipped to the site and fabricated there. The only difficult part is learning to use the

jack to post-tension the bars. Depending on the substructure, all of these bridge types could be constructed by an agency's own crews with very little equipment involved and the deck should take only a couple of days to construct.

The cost will vary depending on the substructure and the type and availability of the preservative treated lumber. Typically, concrete and steel are much more expensive and harder to work with than wood, especially on short spans. Nail-laminated decks have a shorter life expectancy, although the cost would probably be the lowest of the three. The glue-laminated has a very long life expectancy but also a higher cost. There are not that many glue-laminating plants so shipping should be a consideration. The stress-laminated has an unknown life expectancy. Restressing would have to be done about every 10 to 20 years, but because few have been in 10 years and none for 20 years, life expectancy is still unknown. With proper preservation, it should last a long time. The cost should be less than the glue-laminated, closer to the cost of a nail-laminated. Maintenance costs are minimal. Inspections for deterioration need to be performed, protection needs to be applied on cracks, splits, etc., and the wearing surface will need to be reapplied on occasion. Once the stress-laminated deck design is perfected, restressing will need to be performed, but this would only take a couple of hours and two people.

Preservative Treatment

The main reason wood is not used as much as other materials is because it does not seem to be as durable. Problems such as insects and decay can shorten the life of wood greatly depending on the geological area in which the wood is being used. There are four components that are necessary for fungus, which leads to decay, to grow and these are oxygen, temperature, food and moisture. Little can be done to reduce oxygen. Fungus grows from freezing temperatures to an optimum growth temperature of 80 degrees. It is dormant below freezing and only a wood temperature above 100 degrees is lethal. Little can be done to affect wood temperature in such an extreme way. The two variables that can be affected are the food source which can be made poisonous and the moisture content which can be kept below 30 percent. Preservative treatments are used to poison the food supply. Creosote and penta chlorephenol in heavy oil, penta chlorephenol in light oil, and water born salts such as ammoniacal copper arsenate (ACA) or chromated copper arsenate (CCA) are types of preservative treatments in use. The types in heavy oil are preferred because the oil retards moisture penetration and the water born salts are not used a lot because the salt increases the absorption of moisture. Preservative treatments should be performed on the lumber only after all cutting and drilling have been performed. As few field cuts as possible will reduce the possibility of exposed raw wood. If field cuts are necessary, there are preservatives that can be sprayed on, the best being copper naphthenate. When checks or cracks occur, especially on guardrail posts, the area should be sprayed with a preservative and then roofing tar can be applied to keep out excess moisture. Any punctures into the unpreserved wood can lead to decay and should be treated immediately. All timber used in the bridge should be placed at a moisture content of 19 percent or less. This is considered the moisture content wood will natural dry out to. There will be variations but it will typically stabilize at 19 percent. The best way to keep moisture out is to use a waring surface. This protects the surface of the deck from wearing down and can assist in making the deck waterproof so that moisture is not accumulating in the wood members below. The longest lasting timber bridges are covered bridges because there is a roof to keep out the moisture.

Wearing Surface

There are several types of wearing surfaces. The best type for waterproofing is asphalt or a chip seal. To reduce reflective cracking especially on nail-laminated or glue-laminated decks, an asphaltic backed geotextile material should be placed between the deck and the wearing surface. Both of these types of decks will leak without surfacing and the glue-laminated panels are always dried to 19 percent moisture content so excess moisture on the surface will cause swelling which could cause problems with the guardrails and doweled connections. The stress-laminated to not tend to leak through the deck so surfacing is not needed for waterproofing. But, the lumber making up the deck could swell causing excessive stress on the bars and possibly failure. In all cases, without a wearing surface, traffic will wear down the deck to untreated wood increasing the possibility of deterioration. Inexpensive types of surfacing are wood planks covering the entire deck or wood planks used as running boards. In both cases, nails or screws would be used to secure the planks. The penetration of these into the untreated wood could lead to decay so treatment of the holes would be necessary. A layer of soil could be placed over the deck but the thickness could be as much as 12 inches due to possible rutting which would be a heavy dead load not considered during the design of the deck and the soil could trap moisture at the deck surface which could lead to decay. Solutions to the problems of some of the wearing surfaces are being examined so that a wearing surface of some type can be placed on all bridges.

Conclusion

The three basic types of bridge deck designs are nail-laminated, glue-laminated and stress-laminated. All three types are easy to construct and relatively inexpensive

compared to concrete and steel with the glue-laminated and stress-laminated having the longest life expectancy. But the life of the bridge depends on the preservation of the wood. Preservative pressure treatment and few field cuts will reduce the possibility of deterioration due to insects and fungus. Placing all wood at a moisture content not to exceed 19 percent and keeping moisture from the wood will inhibit the growth of fungus which leads to decay. The best way to reduce wear on the surface of the deck and reduce the amount of moisture in the wood, is to place one of several types of wearing surfaces on the deck. Timber bridges can be competitive with other materials for short span bridges but they must be treated properly in order to live a long, healthy, relatively maintenance-free life.

Central Tire Inflation–What's In It For Me?

Paul Greenfield, Program Leader of Road Technology
USDA Forest Service, San Dimas Technology and Development Center, San Dimas, California

History of Reduced Pressure Tires For Logging

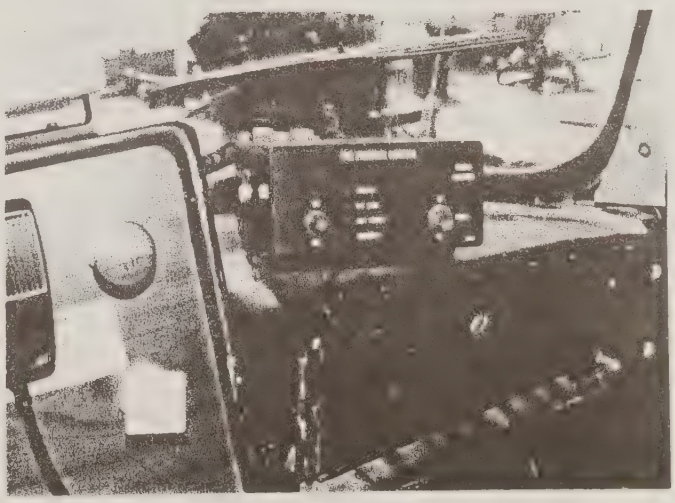
In the early years of the current (20th) century, loggers determined that softer tires did much to improve the operation of their logging trucks. Specifically, in the mid-1920's, an attempt was made to provide a softer tire by first thickening the cross section of the solid rubber tire in use at the time and then putting holes through the rubber to produce some "give" in the tire. In the late 1920's pneumatic tires came into use.

Then, in 1934, Lloyd Christensen (a log trucker who worked in Oregon and Washington) and the Goodyear Tire & Rubber Co. developed the 14-ply 10.00 x 20 tire that became the standard in log trucking for many years. In succeeding decades, tires on logging trucks have had their pressures increased time after time—until these days pressure is in the 90 to 120 psi range. Once again loggers are experiencing the road damage, traction problems, and excessive truck maintenance that they did with early solid rubber tires. A system that is available nowadays to soften tires by reducing tire pressure is central tire inflation.

What Is Central Tire Inflation?

Central tire inflation (CTI) is the term used for a mechanical system, installed on a vehicle, that allows the driver to adjust tire pressures while the vehicle is in motion. With CTI, tire pressures can be varied to realize the maximum benefit for any given load, speed, and road condition. The fuel efficiency and tire life benefits of using high pressures on high-speed highways can be realized, while—at the same time—also gaining all the benefits of reduced pressure tires on low-speed forest roads.

Flexable Line to a Rotating Air Joint on the Outer Hub of a Wheel.



Control Panel.

Benefits Of Reduced Pressure Tires On Low-Speed Forest Roads

A reduced pressure tire using CTI results in a longer footprint; this prevents the bouncing that occurs from short contact lengths. "Bounce" causes the tire to hop on paved roads and to "washboard" on unpaved ones. The U.S. Army has utilized CTI since World War II to improve vehicle mobility. Benefits of operating reduced pressure tires on low speed forest roads include:

- Decrease road surface damage
- Decrease road maintenance needs
- Decrease use of road-surfacing material
- Decrease truck maintenance needs
- Decrease tire injuries
- Subdue vibrational inputs to driver, passengers, and cargo
- Increase truck mobility
- Extend haul season

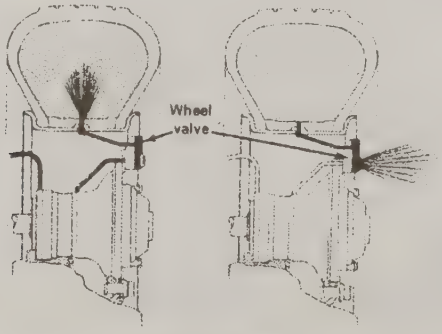
In addition, the Forest Service has learned from tests of reduced pressure tires that they provide additional improvements by:

- Healing rutted and washboarded unpaved roads
- Increasing road pavement life over saturated upgrade condition

Adequate tire pressure must be maintained for highway speeds. CTI systems are being used to attain both high tire pressure for highways and appropriate lowered tire pressure for low-speed forest roads.

How Does CTI Inflate Rolling Tires?

Several very ingenious methods for inflating and deflating rolling tires have been developed. External systems run the air through a flexible line to a rotating air joint on the outer hub of the wheel. Internal systems route the air from the fixed axle housing or brake plate through a seal to the rotating wheel, axle shaft, or hub.



Internal Valve System.

Advantages Of CTI

The advantages of using CTI were investigated by the Forest Service beginning in 1983. With 95 percent of the 350,000 miles of Forest Service roads unpaved, a significant portion of the budget is used for road construction and maintenance. The roads are necessary for protecting, producing, and transporting resources of the National Forests.

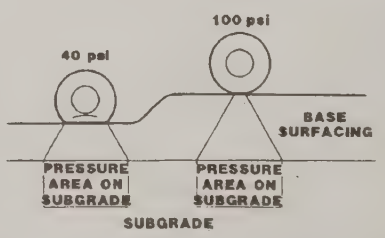
Ways to reduce costs of these roads is an Agency goal. Tests conducted by the Forest Service throughout the United States show dramatic improvements in road conditions brought about by the use of increased tire footprint area made possible by CTI systems. In addition to the benefits already cited, CTI systems can offer the following advantages:

- Constant monitoring of tires to detect leaks
- Inflation of leaking tires to prevent flats
- Devices showing possible high-speed/ low-pressure operation
- Quick inflation/deflation using switch in cab

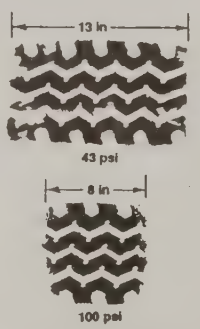
For additional information on CTI, contact:

USDA Forest Service
San Dimas Technology & Development Center
444 East Bonita Avenue
San Dimas, CA 91773

Telephone: 714/599-1267: FAX: 714/592-2309



The Thickness of Road Aggrigate Required to Spread the Load to a Pressure Appropriate for the Subgrade Material.



Contact Patch Length Change for Different Tire Pressures.

Foam As A Fire Suppressant: An Evaluation

Paul Schlobohm and Ron Rochna,Fire Management Specialists, Boise Interagency Fire Center, Bureau of Land Management, USDI, Boise, Idaho

The ability of fire suppressant foams to improve ground-applied fire control efforts was evaluated. Foaming agents and foam-generating systems were examined. Performance evaluations were made for direct attack, indirect attack, and mop-up. Foam was determined to suppress and repel fire in situations where water would not. Cost comparisons of mop-up work showed straight water to be significantly more expensive than foam. Foam will replace all current water applications and present new suppression opportunities to the fire management community.

The Bureau of Land Management (BLM) is evaluating the effectiveness of foam as a means of controlling fire. The impetus for this study can be described by the reality of current ground-applied fire control efforts. Wildfire suppression capability is limited where water is scarce and real property values are threatened. Prescribed fires are often difficult to contain. Time-consuming mop-up reduces further burning opportunities.

The Concept Of Foam

The concept of foam is not new, but the limited use of foam in wildlands warrants a review of its capabilities. Foam extends the life and effectiveness of its water. Foam reduces the surface tension of water molecules enabling greater penetration of the water. Soap-based foam opens the waxy coating of green vegetation, further enhancing wetting ability. Foam inhibits water flow, allowing more of the water applied to be used for cooling. As foam, water becomes a reflective, insulating blanket (3, 4).

Foaming Agents

Foam systems as recent as 1985 relied on foam-making substances not specifically designed for fire suppression. Pine soap or soap skim, popularized by the Texas Snow Job, is a derivative of the paper-making process. Household dishsoap was also used because of its availability (5).

Since 1985 foaming agents designed for wildland fire suppression have been available. These products combine relatively stable bubble structure, improved wetting ability, and vapor suppressants. They provide the capability of instantaneous extinguishment, construction of an impenetrable barrier to fire, and reduced mop-up time.

Foam Generating Systems

Foaming agents can be utilized by a variety of means. Synthetic foaming agents have sparked new interest in the foam generating systems made popular by pine soap. Compressed air foam systems (CAFS) have been modified with centrifugal pumps and metering devices, and enlarged with 40 cubic feet per minute (cfm) or greater air compressors. Air aspirating and conventional water systems also have applications for foam.

Foam is produced in the CAFS by mixing compressed air and solution at equal or nearly equal pressures and pumping the mixture through one of three forms of agitation. Hoselays longer than 50 feet (of 1 inch diameter) provide enough space for air and water to mix into foam. Scrub chambers, tubes filled with obstructions, force air and water into foam in 1 to 2 feet. Specialized nozzles combine compressed air and atomized solution as they leave the nozzle. Hoselays are the most common agitation method and this discussion will concentrate on their features.

Compressed air systems which pump foam through the hose flow water at less than normal rates. A 1-inch nozzle may flow 12 gallons per minute (gpm) of water as foam at 150 pounds per square inch (psi), with a discharge distance of 85 feet. Water is expanded about 10 times at agent mix ratios of 0.2-0.3 percent. CAFS has the unique ability to change foam consistency by changing water flow rather than mix ratio.

Extra equipment required for the CAFS include an air compressor and full flow ball valves. Compressor size is dependent on need. Generally, 2 cubic feet of air is necessary for every gallon of water to create quality CAFS foam. The ball valves are used as nozzles to shut off the foam flow.

Foaming agents have also initiated the production of a wide range of air aspirating or expansion nozzles. Low- and medium-expansion nozzles produce quality foam. Low-expansion nozzles are most common. They flow 10 to 30 gpm at 150 psi discharging 30 to 70 feet. The air aspirating system pumps solution through the hose and creates foam at the nozzle. Air is drawn into the nozzle when the solution is atomized and passed through a pressure gradient. Water is expanded 5 to 10 times with agent mix ratios between 0.3 to 0.4 percent.

The third system in which foam agents can be used is as a wetting, extinguishing solute in conventional water systems. Through all apparatus from turbo jet to sprinklers to bladder bags, bubbles will form froth due to low agitation. With the surfactant in the water, wetting and extinguishing will increase over straight water.

Technology offers improvements from conventional equipment for mix methods, hose types, hoselays, and nozzles. The inefficiencies of batch mixing concentrate and water are overcome with eductors or proportioners. Eductors also make possible the use of foam when the sole motive force is a water pump. A portable pump, for example, can draw concentrate into the hose as it pulls water out of a stream. Proportioners, which pump concentrate as desired into the water line, have the accuracy and dependability necessary to be integral engine components.

Hose types are important when foam is pumped through the hose (CAFS). Durable woven rubber hose is used to avoid kinking. Any restriction in a hoselay will breakdown bubbles thus significantly reducing foam quality and discharge capability. Hose which is porous or has an irregular lining will disrupt foam flow and reduce discharge performance (table 1).

Hoselays can be different for the CAFS depending on application. Usually, foam barriers are applied with one or two nozzles. Since foam is compressable, hoses are easily clamped and extended. Hoses filled with foam do not exhibit all characteristics of hydraulics. Greatly reduced head pressure enables foam to be pumped significantly father above the pump than water (6).

Nozzles vary in performance for aspirated and compressed air systems. Low expansion air aspirated nozzles range in performance for 1.5 inch hose from 7 gpm and 25 feet discharge to 26 gpm and 70 feet discharge at 150 psi. At 35 gpm and 150 psi, a 1 inch CAFS nozzle has a maximum discharge of 70 feet, a sustained discharge of 55 feet; a 1-3/8 inch nozzle: 90 and 70 feet respectively.

Table 1– Hose characteristics important to foam flow.

Hose type	*Resistance to Kinks*	*Resistance to Fire*	*Porosity w/Foam*	*Resistance to Flow*
Synthetic	*poor*	*poor*	*high*	*high*
Cotton	*fair*	*fair*	*low*	*medium*
Rubber	*excellent*	*excellent*	*none*	*low*

Applications

The applications phase of the project directly evaluated fire control potential of foam in the field. Where possible, comparisons were made to water performance. Evaluations occurred on prescribed fires and wildfires throughout the West.

Direct Attack

Visual evaluations of foam's extinguishing capability were made. Flames burning in light, flashy, ground fuels, tall snags, pitchy stumps, red slash concentrations, and desert sage were treated. Extinguishment was instantaneous. For example, two light engines worked the flank of a range fire. The engine using air aspirated foam never had to turn around for rekindled flame. This engine's pumping time was 1/3 greater than the water engine's. The engine using water found some of its flank had started burning again (7).

The compressed air foam system has great extinguishing capability in part because foam can be indefinitely compressed in the hose. The ball valve can be shut off without risk of bursting hose. This creates back pressure in the hose which, when released, produces a fine-bubbled mist and long discharge distances. The fine-bubbled mist is unique to the CAFS. When released the mist puts on a cooling, suffocating performance that has been compared to halon gas. Together with initial discharge distances of up to 85 feet with 1 inch hose, the mist gives the firefighter a deluge initial attack capability. Many prescribed burn spot fires have been extinguished by merely opening and closing the ball valve.

After the initial, fine-bubbled surge, foam produced becomes thicker. It forms large masses of bubbles which cling together. This clinging property is also an important extinguishing feature. Foam can be lofted onto flames, the clinging bubbles forming a vapor suppressing blanket that also separates oxygen from flame. Because it exhibits low head pressures, foam can be injected into the bottom of a burning snag to extinguish fire burning within. The foam will fill any accessible cavity, suffocating fire.

Protective Barrier

Applications of foam for protection include prescribed burn boundaries, fuelwood piles, snags, wildlife trees, and fragile sites, and backfire wetlines. Twenty firelines adjacent to prescribed fire units have been pretreated with foam. The foam-treated areas adjacent to firelines ranged from 300 feet to 1500 feet in length. Width (25 to 100 feet) and depth (0.25 to 2 inches) depended on the foam generation system and site conditions. The time between application and

ignition ranged from 0 to 45 minutes. Spotting beyond the foam lines occurred on occasion, but no foam line was crossed by moving fire.

Two examples of foam as barrier to fire occurred on the Toad Creek unit in western Montana. Fuel loading was 100 tons per acre of fuel model 13 lodgepole pine/subalpine fir (Pinus contorta var. murrayana Engelm/Abies lasiocarpa) logging slash. The prescription of 40 percent relative humidity, 70 degrees F temperature, and light (1 to 4 miles per hour), favorable winds was met at 2,000 hours. Nevertheless, running flame lengths were 3 to 20 feet high and the fire crowned to 60 feet.

In the first example, a 150 feet by 210 feet by 1 inch foam line was placed across one 1/2-acre corner of the unit. No tools were used, no fuel removed to construct this line. The unit's test fire was lit in the corner. The fire ran quickly to the poles standing adjacent to the line, crowning and producing firewhirls. When the fire reached the foam line, flames leaned over the line, but the fire's forward progress stopped. Time elapsed from foaming to fire contact was 2 minutes.

Lighting of the rest of the unit continued across the foam line. The line was exposed to heating on both flanks for about 5 hours. Inspection the following day showed the line intact, with green vegetation and fine fuels throughout. Two logs greater than 8 inches in diameter which had burned through the line from both ends were the exceptions.

In the second example, a 1,400 foot foam line was placed outside a cut fire trail in an adjacent timber stand. Foam was applied 100 feet wide, 75 feet into the canopy, and 1 to 2 inches thick. Application was 5 to 15 minutes prior to ignition of the adjacent portion of the unit. Two people created this line with one 1 inch hose. Application time was 5-1/2 hours. Fire behavior remained extreme, with long duration, high flame length fire tossing firebrands into the treated stand. Personnel familiar with burning under these conditions expected the fire to escape. The width of the line prevented most firebrands from starting spot fires. One spot that did occur was extinguished with foam from 60 feet away.

Mop-up

Direct foam versus water performance and cost comparisons were made during mop-up operations. Personnel involved were not informed of the comparison to avoid any changes from standard instructed procedure. In each case, the foam crew was mopping up with foam for the first time.

The first comparison occurred during mop-up of a wildfire in felled and bucked Douglas fir (Pseudotsuga menziesii) timber. A four person crew using two nozzles completed 100 percent mop-up of 5 acres in 3 hours with 7,700 gallons of water. Nearby, on 5 acres of the same fire, this productivity was equaled by two 20 person crews employing 24 nozzles and approximately 55,000 gallons of water.

The foam crew used 15 gallons or $225 of foaming agent based on 0.2 percent mixture and a price of $15 per gallon. Assuming the average salaries for the foam and water crews are $7 and $5.50 per hour, respectively, the foam operation cost $309 for labor and foaming agent; the water operation cost $660 for labor.

The second comparison occurred during mop-up of the Toad Creek unit. A five person foam crew mopped up 100,000 square feet in 4 hours. A 25 person water crew mopped up 25,000 square feet in the same time. Both crews had an unlimited water supply. Total water flow for the foam crew was 30 gallons per minute.

Again, 15 gallons of foaming agent were mixed. Using the same wage assumption in the first comparison, the foam operation cost $365; the water operation cost $550.

Foam application technique for both comparisons was designed to let the foam do the work. Foam applied was wetter than the protective foam type. Foam was spread out so that it penetrated and cooled, while the operator moved on. Extra attention to hot spots was given only when heat was well below the surface.

Discussion

Foaming Agents

Of all the types of foaming agents presented, the relatively new synthetic products made specifically for Class A fuels are preferred. The 3.0 percent mix ratios of pine soap are 10 times greater than synthetic. Preliminary laboratory tests have shown pine soap to be an inferior wetting agent. Common dishsoap lacks vapor suppressants and durability. The price of the new agents has continued to drop as the demand for them has increased. Some users have experienced 25 percent reductions in suppression costs despite the $12 to $15 per gallon prices (8, 9).

The notion that water is free is a fallacy. The BLM fights most of its fires where water sources are miles away. Twelve dollars can make 500 gallons of water into 5,000 gallons of effective water as foam.

Foam-generating Systems

Purchasing requirements vary significantly with the three generating systems presented. Foaming agent alone will give one an improved wetting agent with conventional apparatus.

As the minimum initial equipment investment, air aspirating nozzles will assure quality foam production, especially for protection and mop-up. Long-term use of this system is appropriate only if the consistent high use of foam is more tolerable than a high initial investment for the compressed air system.

The CAFS generally requires the greatest initial capital outlay, primarily the air compressor, as well as a retrofitting or new engine package. However CAFS can be assembled on-site from inexpensive components such as rented trailer air compressors, readily available plumbing, and an existing water pump. The high initial cost is quickly returned by increased capability and performance, and reduced volume of foaming agent required.

Applications

The success of foam in the examples given of performance can be attributed to two factors. First, the combination of synthetic foaming agents and the compressed air foam system creates a powerful tool for fire suppression.

Second, proper training is necessary to ensure success. Foam can fail and if its properties and uses are not understood, it will. Foam should not be considered a cure for every fire situation. It is simply a very useful tool.

Foam must be of the appropriate consistency: wet, dripping, or dry. It must be applied for the appropriate effect: lofted for intact, clinging, and smothering bubbles; pressure impacted for broken, wetting bubbles.

Foam is designed for short term use when applied as a barrier. Its effective lifetime varies with fuel, weather, and fire conditions. Applications must be adjusted accordingly.

Safety precautions should be understood when using foam. Foaming agents are mildly corrosive to skin and eyes. Protective gear is recommended. The high-pressure lines of the CAFS should be operated with caution. Valves must be opened slowly to prevent nozzle kickback and hose whiplash.

The Future

Over the past 2 years foam has developed into a tool for the future. The full potential of foam has yet to be realized. In fact, the technology of Class A foam fire fighting is expanding beyond Class A fires. Cost-effective, successful applications have been demonstrated with hydrocarbon fires, vehicle fires, and structure fires. Methods of delivery are also expanding to fit different needs and resources.

The wildland-urban interface fire protection program may have the most to gain from foam development. Research must increase our understanding of foam processes. Training of application techniques must begin. The days of fighting fire with unrefined water are numbered. Water has served us well in fire suppression over the years. As we move into the twenty-first century, water will serve us even better as foam.

Godwin, D.P., 1936. Aerial and chemical aids., Fire Control Notes 1(1). Washington, D.C: U.S. Department of Agriculture; 5-10.

Everts, A.B., 1947. A dual purpose hazard reduction burner and foam unit. Fire control Notes 8(2,3). Washington, DC: U.S. Department of Agriculture; 10-12.

Ebarb, P., 1978. Texas snow job. Fire Management Notes 39(3). Washington, DC: U.S. Department of Agriculture; 3-5.

Data on file, Department of Interior, Bureau of Land Management, Boise. Interagency Fire Center, Boise, Idaho.

Carriere, Al, Fire Management Officer, Lakeview District, Bureau of Land Management, U.S. Department of Interior. (Telephone conversation with Ron Rochna). 20 July 1986.

Momber, Jerry, Forester, Simpson Timber Company, Eureka, California. (Personal conversation with Ron Rochna) 5 May 1987.

Data on file, Department of Interior, Bureau of Land Management, Salem, District, Salem, Oregon.

Foam Generating Equipment

Dan McKenzie, USDA Forest Service, San Dimas Technology and Development Center, San Dimas, California

On-Hand Equipment/Aspirating Nozzles/ Compressed Air Foam Systems

When fighting wildfire with foam, the foam generating equipment can range from the use of current equipment (tank, pump, and plumbing) on hand to specially developed, high-performance compressed air foam systems (CAFS). To use on-hand equipment, one just pours a foam concentrate into the water tank, to the desired proportion to make foam

solution, and then goes at it. To make improved foam, an aspirating nozzle can be added for a cost of some as low as $20. CAFS is the next step up from the aspirating nozzle. CAFS is the injection of compressed air into foam solution, generally at the engine, and running the produced mixture through a length of hose or mixing device to produce a uniform foam. The advantages of a CAFS unit over an aspirating nozzle include (1) the foam can be projected further, (2) less foam concentrate is used, and (3) smaller more uniform bubble, longer lasting, foam can be made.

An added advantage of CAFS over an aspirating nozzle is that the aspirating nozzle can only make one type of foam–wet sloppy, while a CAFS unit can make different types of foam–all of which generally last longer than aspirating nozzle made foam. For a number of reasons it is not desirable to add foam concentrate directly to the water tank. Therefore, both when using an aspirating nozzle and CAFS, proportional, direct injection of the foam concentrate into the discharge side of the pump is what one should use.

Aspirating Nozzles: Aspirating nozzles create foam by (a) atomizing the foam solution stream, (b) drawing air into the stream, generally by venturi action, to create a froth, (c) mixing the froth in an expansion chamber to enhance and strengthen the bubbles, and (d) discharging the foam. The aspirating nozzle is a low-energy system for making foam; for only the energy in the water stream is available. In general, aspirating nozzles which have long reaches, by using the water stream energy to project the foam, will only produce wet, frothy foam. Aspirating nozzles which use most of the water stream energy in making bubbles, will create a drier, more uniform bubble, foam that is only projected short distances. For there is only a given amount of energy in a water stream–if you want to educt air to create foam, this will require the use of energy for projecting the foam resulting in reduced discharge distance. Aspirating nozzles normally require at least a 0.5 percent foam solution to operate well.

Compressed Air Foam System (CAFS): CAFS–at one time known as the "Texas Snow Job"–was first put into service by the Texas Forest Service in 1977. CAFS features the injection of compressed air (or other pressurized gas) into foam solution (foam solution is water and foam concentrate in the correct mix ratio). In CAFS, less foam concentrate is generally used (0.3 percent) than with an aspirating nozzle. CAFS is a brute force method of producing foam; therefore, almost any foam concentrate will "work." Injection of air usually takes place at the engine, mostly at operating pressures of 80 to 100 psi. Higher or lower pressures are also used–depending on hose size and length.

Direct Injection/Equipment Components

Both the aspirating nozzle and CAFS should use proportional, direct injection of the foam concentrate into the exiting water stream to make foam solution, since adding the foam concentrate directly to the water tank or passing it through the pump (suction side proportion devices) is not desirable for the following reasons:

- Corrosion (caused by the foam concentrate clearing the tank, pump, and plumbing)
- Pump priming difficulties
- Water-level gauge troubles
- Foaming in tank
- Foam proportion cannot be conveniently changed while opperating (It can be increased by adding more foam concentrate to the water tank)
- When refilling a partially used tank of water, dip sticking or gauging is required
- Fire engine cannot draw water directly from a nurse tanker or hydrant and make foam solution
- Foam solution biodegrades over time, tends to lose potency, and does not foam as well
- Contamination of the water tank—making water from the tank unusable for other purposes (such as drinking or supplying water for lookout towers)
- Use of more foam concentrate than required
- Problems with pump and valves caused by the foam concentrate washing out their lubricants

For these reasons and others, proportional, direct injection of the foam concentrate on the discharge side of the pump is very desirable in both aspirating nozzles and CAFS units. There are a number of direct-injection proportioning systems on the market (or under development), for use with both aspirating nozzles and CAFS units, which proportionally inject foam concentrate into the discharge or high pressure side of the pump for use with both new and existing water pumping equipment.

Pumps: Both types of pumps used in firefighting can be used with foam generating equipment. Early CAFS used the positive-displacement pump. However, a method of using the centrifugal pump was developed–allowing the centrifugal pump to work very well with CAFS. There are major

advantages to using a centrifigual pump with CAFS, for there is no deterioration of the water handling performance nor of the reliability of the fire engine related to water handling.

Air Compressors: There are several types of positive-displacement air compressors–piston, rotary van, rotary helical screw, and rotary lobe. The piston type is by far the lowest cost and simplest. The rotary screw has a major advantage over the piston air compressor in that it can modulate output. Because of this, the rotary screw compressor is becoming popular for use in CAFS, despite its higher cost. Very little if any air storage is required for CAFS, for the system will generally use all the air that is produced and at the rate at which it can be produced. In the larger systems, using the rotary screw type air compressor which will modulate output, no air storage is necessary.

Power Sources: When using aspirating nozzles, the power for the foam generating equipment can be a power takeoff (PTO) from the the truck transmission or an auxiliary engine. CAFS can also be powered by the truck engine or an auxiliary engine; however, special methods must be used. When using the truck engine to drive a CAFS unit, a hydrostatically driven system should be used to drive the centrifugal pump and air compressor. If CAFS is to be driven by an auxiliary engine, a single auxiliary engine can (and probably should) be used. For, when a single auxiliary engine is used–and engine horsepower, pump gearing, and air compressor gearing are properly selected and well matched–the single-engine CAFS works very well.

Equipment Selection/Flowmeters

Major components of foam generating equipment have just been covered; however, the question is what should be used. For aspirating nozzles usually the standard water handling equipment can be used with the addition of a pump discharge, direct-injection, foam concentrate proportioning system. For CAFS, a little more guidance is needed.

For CAFS or aspirating nozzles the pump should be a centrifugal pump because of the major advantage of no deterioration of the water handling performance not of the reliability of the fire engine related to water handling. For wildfire, the pump performance should probably fall in the following ranges 50 to 70, 90 to 120 and 190 to 250 gpm.

The air compressor could be either a piston or rotary screw. The rotary is becoming preferred because it modulates output. For wildfire, the compressor output should fall in the range of a minimum of 40 to 100+ cfm. The minimum flow will operate well a short (up to 200 ft) 1-inch diameter hose; 100 cfm will operate very well a short (up to 200 ft) 1-1/2-inch hose. The power source should be the truck engine or a single auxiliary engine; in either case the unit should be able to make a running attack.

A CAFS unit should have a system that proportionally injects foam concentrate into the discharge side of the pump. This means that no foam concentrate has to be added to the tank nor run through the pump.

One more area of guidance for a CAFS unit is to have flowmeters on the water, air, and foam concentrate lines. When the end of the hose is close to the engine, and the engine operator can see the discharge, these may not be very important. But, when fighting wildfires, frequently the hose ends up going over the top of the hill; then the engine operator cannot see what is happening at the end of the hose. For, when supplying a long hose lay, it is a long time before a change at the end of the hose is seen after an adjustment is made at the engine–sometimes as long as 15 to 20 minutes. For these reasons, flowmeters on a CAFS unit are very important; they show the operator what the unit is doing and, when an adjustment is made, the operator can see whether the adjustment is producing the desired effects. Flowmeters also help in training the operator to produce foam quickly and change the foam on demand.

Hurricane Hugo

Dan W. McKenzie, USDA Forest Service, San Dimas Technology and Development Center, San Dimas, California

On the night of September 22-23, 1989, the eye of Hurricane Hugo made landfall at the city of Charleston, South Carolina. The Francis Marion National Forest, just north of Charleston, took the severest part of the storm with water surges over 20 feet above mean sea level. About 70 percent or more of the

Hurricane Hugo - Francis Marion National Forest

trees over 10 inches in diameter were blown over or broken off 20 to 25 feet above the ground in the 250,000 acre National Forest, with an estimated loss of value of $95 to $115 million. The seed orchard on the Francis Marion suffered heavy damage, with an estimated 95 percent of the trees severely damaged or destroyed. Most of the 576 miles of roads within the National Forest were blocked by fallen trees. Special equipment for preparing fuel breaks along the forest roads such as special wide track crawler tractors and foam fire fighting equipment was researched and put into operation where appropriate. Timber salvage operations were also begun.

The Effectiveness Of Class A Foams

Ronald R. Rochna, and Paul M. Schloblohm, Fire Management Specialists, Boise Interagency Fire Center, Bureau of Land Management, USDI, Salem, Oregon

Suppression of class A fires is dependent on breaking the fire tetrahedron by isolating either (1) air, (2) fuel, (3) heat, or (4) inhibiting the chemical chain reactions. Water has been recognized as a means of suppressing fire since rain was first observed extinguishing the warming fires of early man. It has been used extensively up through the present. The need to apply copious quantities of water has been the driving force in the search to enhance water's suppression capabilities. Currently the answer is the use of a foaming agent. The conversion of water from a liquid to a bubble state imparts new characteristics to the water and results in superior suppression qualities. The foam can affect all four sides of the tetrahedron and also produces side benefits which are an aid to suppression. In some instances a particular function performed by the foam modifies more than one of the fire parameters thereby giving a compound net benefit.

The least complicated relationship is that of the foam and air. The viscosity of water is such that very little adheres to the surface it lands on. It immediately drains off and only a miniscule amount is retained if the surface is not very rough and porous. Foam is semi-fluid in most cases, consequently, gravitational forces are primarily responsible for the gradual flow that is set up after it comes to rest. The result is that a much greater quantity of water adheres and remains on site for a much longer period of time in the foam state. During this interval the foam acts as a durable barrier and excludes the air from the fuel's surface. Vaporized water is trapped at the fuel interface by the foam layer and air pockets in the fuel's proximity attain high relative humidities. Foam impedes the free movement of air and moisture-laden air is not replaced by dry air. When water is applied to live coal the skin-thin layer of water that adheres is readily evaporated and air is permitted to enter and foster combustion. But, when this same volume of water is expanded ten to fifty times, the resulting foam layer forms a protective envelope.

The heat segment of the tetrahedron is severed by foam in several ways. The opaque surface reflects some of the energy that impinges on it and absorbs the balance. The sphere-like structure of the bubbles causes incoming energy to dissipate laterally and localized pre-heating is minimized. The pathway through the bubble mass is made up of the fluid in the bubble skins and the air within these bubbles. These air cells act as pockets of insulation and, as a consequence, radiant energy becomes highly diffused when it enters the foam. The energy that is absorbed is used to evaporate water trapped in the foam structure. The net result is slower evaporation per unit of surface area and an overall delay in the exposure of the fuel's surface to oxygen and heat. The foam physically insulates burning fuel from the surrounding environment. The energy released at the combustion interface is dissipated, and cooling takes place while this barrier starves the burning fuel of oxygen. These inhibiting factors reduce the potential for rekindling; rekindling only takes place where the energy output exceeds that needed to totally dissipate the foam cover.

The fuel segment of the fire triangle is affected by foam in diverse ways. A heavy application of foam does not drain off instantaneously like water but flows gradually, thereby enveloping the fuel particles on which it lands. This results in much more water being held in the bubble structure per unit of fuel surface. The increase in amount means there is more available water for wetting and more available to absorb heat. The surface-active agent in foam reduces the surface tension of water from approximately 73 dynes/cm at 20 degrees celsius to less than 33 dynes/cm, the level specified for wetting agents. A typical relationship between surface tension and mix ratio is:

Foam Concentrate(%)	*Surface Tension(dynes/cm)*
0.00	73.0
0.01	43.6
0.10	23.4
0.30	22.3
0.50	22.4

Class A foam concentrate ratios greater than 0.5 percent increase surface tension of water.

Water in its pure form maintains a strong molecular bond, consequently, its surface resists rupture. The addition of a wetting agent to water weakens this molecular bond and the water's ability to wet and to operate porous materials is greatly enhanced. Because foam stops where it lands and releases its liquid component at a regulated rate, wetting of the fuel is achieved much more efficiently. Hard-to-wet surfaces shed water, but foam adheres to them and it wets these surfaces via the wetting agent. Vertical surfaces are also difficult to wet with water even if they are receptive to water but, in the foam state, a substantially greater amount of water can be entrapped and rendered available for wetting and heat absorption of such surfaces.

Note: The amount of foam that can be adhered to a vertical surface is governed by the foam generator employed (Compressed Air Foam System vs. Aspirated Nozzle) and the concentrate mix ratio.

The uninhibited chain reaction (the flame you see) is the fourth piece of the tetrahedron that foam possibly has an effect on. It must be stated that this effect has only been observed when using a Compressed Air Foam system. It is speculated that if a foam bubble can be generated small enough, a bonding of free hydrogen radicals could take place resulting in an incomplete chain reaction, flame disappears. This is what happens when extinguishing agents such as Halon and dry chemicals are used to extinguish a fire. The effect is to black-out the fire without absorbing vapors or heat. This phenomena has been observed but not been documented and supported with research.

The rigidity of the bubble structure depends on bubble uniformity, mix percentage, exposure to sunlight and wind, and the efficiency of the foam generator. The rate at which the bubble mass reverts to liquid depends on these factors. The slow release of fluid from the foam makes liquid water available for a longer period of time to wet the fuel. Changing water from a liquid state to foam state also enhances the suppressant's ability to penetrate fuel complexes. Water travels along the path imposed on it by gravity and that imparted to it by the delivery vehicle. These forces also apply to foam but, once the liquid aerates to form a bubble mass, it becomes buoyant and its descent path is influenced by air movements. The end result is that foam penetrates through openings to envelop fuels which might otherwise not be wetted. This enveloping of fuels results in an isolation of volatiles emanating from the fuel particles or, as a minimum, a dilution of these volatile substances to a level where the ignition threshold is greatly altered i.e. the ignition temperature is elevated. The breakdown of the foam at a controlled rate not only enhances wetting but also modifies the micro-climate within the fuel complex.

Class A foams are currently the best instrument available to fire organizations to break the air, heat, fuel, and uninhibited chain reactions relationship.

Using The Global Positioning System For Field Location In Forestry Operations

Richard G. Hallman, Program Leader, Missoula Technology and Development Center, Missoula Montana; Frederick L. Gerlach, Professor, School of Forestry, University of Montana, Missoula, Montana[1]

Introduction

The Global Positioning System (GPS) has been under development since 1973. GPS provides precise positioning, timing, and navigation to military and civilian users equipped with GPS receiving instruments. The United States Department of Defense is responsible for the development and control of the system. The navigation component has shown much promise for application in the field activities associated with forestry and other land and water resources.

The first GPS satellite vehicle (SV) was launched in 1978. The SVs or NAVSTARs for Navigation Satellite Timing And Ranging are placed in orbits 20,000 kilometers above the earth. Each SV acts as a precise radio beacon, sending code modulated frequencies which can be interpreted by GPS receivers. The receiver processes the SV signals into two and three-dimensional positions at the receiver's antenna. Two-dimensional positions may be obtained when the signals from three SVs are received, and three-dimensional positions are determined from four SV signals received simultaneously. When GPS is completed in 1992, a receiver equipped user will be able to determine the position and navigate point to point anywhere at anytime.

Positioning capabilities of the geodetic survey level are truly remarkable, producing point position accuracies within centimeters. The capabilities at the navigation receiver level are less accurate but still useful for field surveying of lower order.

The potential for the application of GPS navigation is enormous. In forestry activities, the applications may be as varied as locating forest fires, guiding field crews, finding survey monuments, locating land parcels or digitizing any kind of field information. The USDA Forest Service began the implementation of new field location methods in 1983 because of the many possible uses of satellite navigation methods.

Development Of GPS Use In The Forest Service

The first step taken toward the implementation of satellite location technology in field operations was the establishment of the field locator project at the national office of the USDA Forest Service. This project overviewed the technology under development reviewing the need for new field location technology. Foresters and other specialists working in the field were questioned concerning the need. Initially, over one hundred separate field tasks were identified as potential uses for satellite location technology.

The field locator project was moved to Missoula, Montana, in 1986 under the administration of the Technology and Development Center.[2] In cooperation with the School of Forestry,[3] a facility was established for the field evaluation of satellite navigation instruments and the training of potential users.

The facility was located at Lubrecht Experimental Forest (School of Forestry) where a controlled, inventoried and mapped test area existed. A number of field evaluation courses were located within this area. The courses were designed to provide typical forest work situations for the evaluation of satellite navigation instruments. The work situations included point to point navigation, plot positioning, traversing, profiling, corner searching, field digitizing, and others. The courses were also planned within a range of slope, aspect, elevation, forest canopy and tree size conditions. A precise GPS survey was completed in early-summer 1987 to provide World Geodetic System 1984 (WGS84) coordinates for base stations in the test area. Subsequent precise ground surveys placed WGS84 coordinates in two of the courses.

GPS navigation receivers became available for field evaluation in mid-summer 1987. Under open sky conditions, the instruments produced positions within 25 meters (X,Y) of the true position in most situations. The means of hand-recorded observations were often within 10 meters (X,Y) of the known position. Mean vertical positions were often more than 25 meters (Z) from the surveyed positions.

The receivers produced positions under a variety of canopy conditions with varying success. Although these instruments were field portable, they were not designed for the rigors of forestry field work.

In the spring of 1988, the Technology and Development Program obtained the first commercially available GPS receivers designed for land navigation. These receivers were the PATHFINDER model manufactured by Trimble Navigation, Ltd. (USA). This receiver including the control/display unit, antenna, power supply and carrying cases weighed less than five kilograms. The instrument, then, became highly portable. The operating system allowed for several modes of operation. The control/display unit was also a recording unit. This capability provided for the use of two receivers operating simultaneously in a differential mode. The new navigation receiver capability also provided for post-processing of the collected data in a personal computer. One receiver could be set up on a base station of known position to record simultaneously with a second receiver set up on unknown positions. In post-processing the base station record of position errors could be used to correct the observations of the unknown positions. This is a differential mode of operation using navigation receivers. The results of the observations of a single receiver (operating independently) is called an autonomous mode of operation. A reading of position at a moment of time is called a real time observation.

Foreseeing the need for GPS user training, the Forest Service supported the development of field training seminars for resource managers. Four seminars (15 students each) were presented in 1988 at Lubrecht Experimental Forest. The seminars gave the students real experience in using GPS receivers under typical forestry field conditions.

The combined experience of the instrument evaluations and training seminars produced increased confidence in GPS for forestry use. In the open, navigation to a point was nearly always within 25 meters (X,Y). The real time positioning of a point was always within 25 meters (X,Y) of the known position. With the recording of 100 observations, the mean autonomous position was always within 10 meters of the true position. In the differential mode of operation, the position determination was almost always within three meters of the known position without any obstructions to the signals.

The instrument readings of position are in latitudes and longitudes (degrees, minutes, and seconds) and height above ellipsoid (meters) in the WGS84. For comparison to local areas and local maps, these coordinates must be transformed to other ellipsoidal and geoidal references.

The early experience under the forest canopy produced mixed results. Many interruptions occurred in the sequence of observations and accuracies seemed to be affected. This problem was explored in a study of canopy effects during the Fall of 1988. The results show a significant reduction in the efficiency of GPS receiver operation under the existing canopy conditions. In turn, this seriously affects the differential model of operation, and has some lesser affect on autonomous operation. Accuracies are also affected. An important consideration, however, is that good positions were obtained at nearly all of our test points at some time.

Four more field training seminars were presented in 1989 along with continuing receiver evaluation. There is a present

expansion of the development of geographic information systems (GIS) in resource management at the personal computer level. This development is rapidly increasing the demand for better positioning for all kinds of mapped and unmapped information. A GPS navigation receiver is a natural field digitizer. A receiver is capable of producing new positions every 1.5 seconds in the open. Using a recording GPS receiver, field digitizing by walking, riding or driving a vehicle is incredibly fast. Certain types of resource information (like soil or habitat type lines) might be more rapidly and accurately digitized in the field using a GPS receiver. Also, due to rapid changes in the cultural detail on the ground, maps are quickly obsolete. Updating or revising of maps or GIS databases seems to be a logical and immediate use of field digitizing with GPS receivers. Much of our work during 1989 was associated with the problems of field digitizing. We will continue to evaluate new GPS receivers, study canopy effects, study field digitizing, and train GPS users during 1990.

Currently, there are over fifty GPS navigation receivers in operation in the USDA Forest Service. And, there are over 120 trained users of GPS receivers. The reports from these users indicate much success for the applications of GPS receivers in a wide range of forest and rangeland conditions. The applications vary widely for: (1) determining the area of a timber harvest, (2) locating a trail on the map, (3) digitizing a new road for map revision, (4) finding a sample plot location, (5) finding lost survey monuments, (6) registering satellite imagery by digitizing identifiable features, (7) positioning forest pest and disease development centers, and (8) many others. As in any form of data/information production, reliability is a very important consideration. The user must be attentive to quality control of the data.

Summary

The work so far has utilized the NAVSTARs launched before 1985. These satellites form Block One, the prototype system. The satellites in Block One provided about four to six hours of three-dimensional position coverage for North America. Other parts of the world may have had less coverage due to the orbit stationing of the SVs. For most of the period (1987-89), seven satellites stationed in two orbital planes were available for observation. At any one time, the configuration of the satellites produces a geometric condition affecting the accuracy of the solution for position. Of course, this can vary much for any set of three to four satellites as they move across your view of the sky. The accuracies noted before can only be achieved with the best geometric configuration of satellites. Very often the actual observing periods were less than four hours when quality was considered.

Presently, the operational system (Block Two) is under development. This system will consist of twenty-four satellites with spares. At the expected completion of 1992-93, this system will provide worldwide three-dimensional coverage.

The USDA Forest Service plans to continue the evaluation of the new satellite navigation instruments as they become available. The continued study of various applications given the new Block Two conditions will also be important. The completion of Block two should improve the operating efficiency of GPS receivers in forest conditions.

The following list of publications have been generated since the beginning of this project.

Amundsen, E.W. 1986. Position Locating Equipment for Better Wildland Management. Presented at the ASPS-ACSM Fall Convention, Anchorage, AK.

Gerlach, F.L. 1989. GPS Canopy Effects Study. Coordinate Locator Project Reports, USDA Forest Service, Technology and Development Program, Missoula, MT.

Gerlach, F.L. and A.E. Jasumback. 1989. Digitizing Natural Resources with GPS (Abstract). Proceedings of the 12th Canadian Symposium on Remote Sending (IGARSS 1989), Vol. 3, p. 1590.

Gerlach, F. L. and A.E. Jasumback. 1988. Evaluation of GPS Instruments for Resource Management Applications. Proceedings of the Institute of Navigation Satellite Division's International Technical Meeting. Colorado Springs, CO., pp 503-510.

Jasumback, A.E. 1987. Evaluation of the NAVCOR 1 Global Positioning system. USDA Forest Service, Technology and Development Program, Missoula, MT.

Sears, N., F.L. Gerlach, and R.G. Hallman. 1987. A Field Facility for Evaluating Satellite-Based Automatic Position and Navigation Instruments. American Society of Agricultural Engineers. St. Joseph, MO.

---

[1]A paper presented int he Peoples Republic of China for the Citizen Ambassador Program of People to People International, April 1990.

[2]Anthony R. Jasumback, Director. Field Locator Project, Technology and Development Program, USDA Forest Service, Missoula, MT 59801.

[3]Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula, MT 59801.

Use Of Video–Camcorder To Document Sagegrouse Use Of Sagebrush

Fred J. Wagstaff and Bruce L. Welch, Range Economist and Principal Plant Physiologist, USDA Forest Service, Intermountain Research Station, Shrub Sciences Laboratory, Provo, Utah

Use of video–camcorder to document sagegrouse use of sagebrush

I. Background
  A. Our problem
    1. Multiple birds–multiple plants
    2. Plant layout–random placement in rows 6 x 6 spacing
    3. Blind spots because of posts and rails on enclosures
    4. Low temperatures–December
    5. Visible recording of time in seconds
    6. Needed total enclosure coverage
  B. Equipment specifications
    1. Long tape time
    2. Visible time clock in seconds
    3. Good resolution
    4. Zoom lens
    5. Relatively simple to use
    6. Use multiple power sources
      a. DC auto battery
      b. Integral–rechargeable power source
      c. Cigarette lighter in truck
      d. AC power
    7. Low temperature tolerance
    8. Large area coverage
    9. Affordable <$1,500

II. Our Experience
  A. Equipment
    1. Several brands met most of our needs
    2. Final selection was based on tests and personal preference
    3. No brand would do everything we wanted
    4. Found we would need two cameras to give the resolution and coverage
    5. A tripod is needed particularly on telephoto
    6. Low temperature problem was solved by using camp trailers and trucks as filming blinds. We did have to keep the windows open to prevent frost accumulation. Placing a Coleman lantern on the floor under the camera tripod provided sufficient heat.
  B. Site and Birds
    1. Put colored bibs on the birds
    2. Put numbered stakes by every third row of plants

III. Conclusions and Recommendations
  A. Video–camcorders can be used to document complex but visible activities of birds
  B. A tripod or window mount is needed to insure high quality photography particularly when using Zoom and telephoto.
  C. Use of a 12-volt RV type battery will provide power for several days
  D. Use of audio allows for keeping notes
  E. Use of visible clock is needed where simultaneous actions need to be separated during the reply.

Rehabilitation Equipment Development In Southern Idaho

Mike Pellant, Range Conservationist, USDI Bureau of Land Management, Idaho State Office, Boise, Idaho

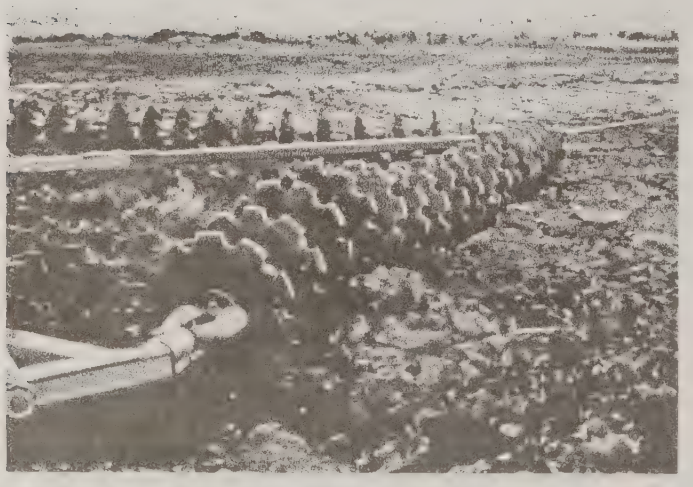
The impacts of wildfires are one of the greatest resource management concerns on rangelands administered by the Bureau of Land Management (BLM) in southern Idaho. Equipment development and modifications are needed to implement a "greenstripping" program (establishing strips of fire resistant vegetation) and to improve shrub restoration practices. Described below are modifications recently made to the BLM's disk chain and a new sagebrush seeder and chain harrow.

Disk Chain Modifications

Idaho BLM has been using a disk chain (Pellant 1988) to prepare seedbed and plant perennial vegetation in cheatgrass dominated rangelands. Several modifications have been made to this original unit to correct deficiencies and to improve effectiveness. The chain link to disk ratio was two to one on the original unit. The distance between disks (36 inches) precluded a full turnover of surface soil, thus competition from undesirable annual species was not adequately controlled. This problem was especially evident on sites where fall germination of annual species had not occurred and the soil was dry. Under these conditions the disk chain was only partially effective in reducing annual species competition.

The link to disk ratio has been increased to one to one with the addition of a disk to each chain link. Complete soil turnover is now achieved, improving control of annual species. However, caution must be exercised in using the disk chain under moist soil conditions with abundant litter or shrub cover. Disks accumulate soil and debris to the point where the cutting action is greatly reduced (Figure 13). If the disk chain is used in burned areas without litter or debris, little accumulation of soil or litter occurs.

Other minor modifications to the disk chain have also been made. Wider V-shaped plates have been welded to the roller bar below the seed boxes to increase the area where seedbed compaction occurs. Corrugated seed tubes have been replaced with smooth seed tubes to reduce seed tube clogging. Finally, a "windscreen" has been installed behind the seedboxes to stop seed from blowing behind the roller bar.



Disk and Chain

Chain and Link

Jarbidge Sagebrush Seeder

Recent attempts to reseed big sagebrush in critical wildlife habitat areas have been hampered by difficulties in distributing sagebrush seed over large acreages. BLM's Boise District has constructed a sagebrush seeder consisting of three components. An "EZ Flow" fertilizer seeder distributes sagebrush seed over a 12-foot wide strip. This spreader has good agitation, a large seed aperture size (1.75 inches) and no seed tubes to clog. Drag chains are pulled behind the fertilizer spreader to lightly cover the seed. Finally a vine roller cultipacker consisting of truck tires cemented to a solid shaft firms the seedbed.

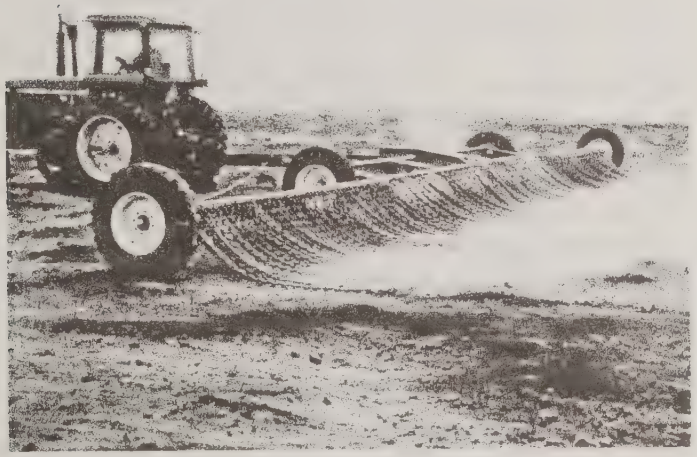
This seeder can be pulled by a two-wheel drive tractor at a cost of $5 per acre for operation. Acceptable sagebrush establishment (1,900 and 17,000) plants per acre at an application rate of 0.7 pounds PLS per acre) was obtained on two projects seeded in the fall of 1987 (Boltz 1989).

Jarbridge Seeder

Chain Harrow

Harrows are an effective technique to lightly cover seed on rangelands free of obstructions. However in areas with rock outcrops, conventional harrows are easily damaged and of limited value. BLM's Boise District has constructed a chain harrow to solve this problem. This unit consists of a 54-foot wide elevated frame with 8-foot segments of 5/8-inch diameter chain attached at 4-inch intervals. The frame is mounted on truck tires and has sufficient clearance to pass over surface rocks up to 24 inches in height.

It can be pulled with a two-wheel drive tractor (60 to 80 horsepower) at operation speeds ranging from 2 to 6 miles per hour, depending on the amount of rock in the area. On a project with moderate amounts of rock outcrops, an average of 20 acres per hour was treated with the chain harrow. Soils were gravelly loams and dry at the time of treatment. A 1/2-inch deep furrow was created by each chain. On sites with soddy soil conditions, surface soil disturbance is minimal.



Chain Harrow

Total cost of labor and materials to construct the chain harrow was $8,500. Weight of the unit is 7,500 pounds. The chain harrow should have the greatest application on coarse soils or when light seed coverage is required.

Literature Cited

Boltz, Michael. 1989. Dual seeding to establish grass and shrubs on burned sites in southwestern Idaho. In: Abstracts, 1989 Society for Range Management Annual Meeting, Billings, MT

Pellant, Mike. 1988. Use of disk chain on southern Idaho's annual rangeland. In: Vegetative Rehabilitation and Equipment Workshop: 42nd Annual Report, Corpus Christi, TX, p. 40.

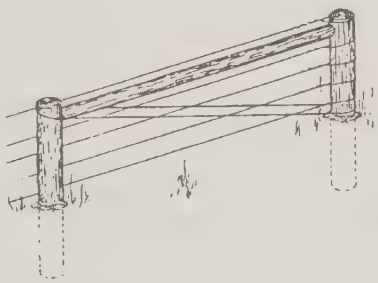
Fence Brace Designs

Dan W. McKenzie and Jeffrey White, Mechanical Engineer, USDA Forest Service, Technology and Development Center, San Dimas, California and formerly with USDA Soil Conservation Service, Lassen Gold Mining, Susanville, California

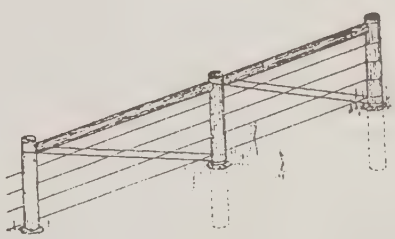
Horizontal Braces

Corner, line, gate, and fence end braces are a very important part of any fence. With the use of high tensile smooth wire, braces are of even greater importance–for when using this where, the complete fence must be maintained at the recommended tension to be effective. In recent years, the horizontal fence brace and the double horizontal fence brace have been accepted as the standard and strongest fence brace design. These braces are very good; however, there are other brace designs that are as good or better, and cost less for materials and installation.

Even the cost of a double horizontal fence brace can be lowered by using a single, longer horizontal brace. Calculations show that on a 4-foot high fence, a single-panel horizontal fence brace 11 feet long is as good or better than a 16-foot double horizontal fence brace constructed from two 8-foot panels.



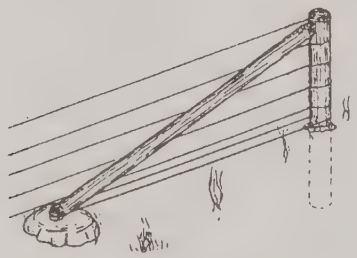
Horizontal Fence Brace



Double Horizontal Fence Brace

Diagonal Brace

The diagonal fence brace (figure 18) is structurally equal to the horizontal fence brace and is less costly for materials and installation, since one less hole has to be dug, one less post has to be purchased, and no measuring or fitting is required to install it. When used on a 4-foot high fence, a single diagonal brace, 11-feet long along the ground, is equal or better than a double-panel horizontal fence brace 16 feet long. A diagonal fence brace is equal in strength and holding force to a horizontal brace because it has the same lifting force on the corner post and the same soil reaction forces as a horizontal brace of the same size (i.e., length of brace on the ground).



Daigonal Brace

In the design and installation of a diagonal brace several principles should be kept in mind:

1. Make the diagonal brace–as is also true for the horizontal brace–as long as possible; up to about 11 feet along the ground for a 4-foot high fence. This is approximately 5.5 times the average wire height. Lengths of a diagonal beyond about 11 feet for a 4-foot high fence adds very little, and are not necessary. The brace will be as effective as necessary with an 11-foot diagonal.

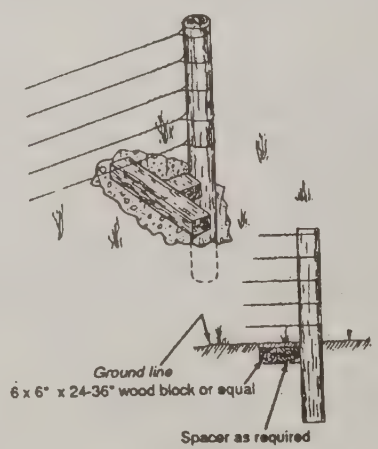
2. Be sure that the end of the diagonal brace in contact with the ground is free to move in the direction of the fence pull; it must not be blocked by a stake or fence post. (Reason: When the end of the diagonal bears against a stake or fence post and is not free to move in the direction of fence pull, one-half to two-thirds of the total fence tension can be transmitted to the stake or fence post. This greatly reduces the ability of the corner post of the brace to resist pullout (failure).)

3. The diagonal brace can bear against the corner post in any location from the middle of the post to the top. However, probably the best place to have the diagonal brace contact the corner post is at the top. (Reason: The maximum bending movement of the corner post–located at ground level where the brace wire is attached to the corner post–is the same whether the diagonal brace bears at the top or the middle of the corner post. However, the loading in the diagonal brace (compression) and lower brace wire (tension) will be double when the diagonal brace bears against the middle of the corner post as of the corner post.)

Block Braces

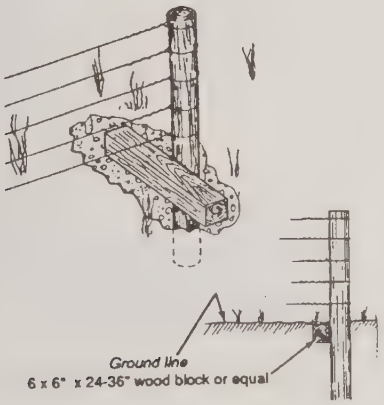
The block brace is another good brace. It's very simple, lower cost, and easy to install–but requires some skill and judgment in where and when to use it. The block brace uses a single post with a block just below ground level to reduce soil bearing loads to acceptable limits. The block has to be large enough so the bearing area of the block reduces the soil loading to that which the soil can carry over a long period of time without movement, even under very heavy moisture conditions. The maximum bending moment (the load or forces trying to break the post in bending) of the vertical post of the block brace is approximately the same as that of the horizontal or diagonal fence brace and located in the same place–at ground level.

The block brace works well in heavy soils and will work well in lighter soils, if the block is made large enough. Also the block brace works best if the block is wedged in place and the block presses against undisturbed soil. If the block is loose, a compression spacer can be wedged between the post and the block to make the block tight against undisturbed soil. Other things that can help make the block brace strong is to set the post down to 36 inches (or more); and cut a wedge out of the block to help hold the post upright. The post can be blocked by any size or shape of block, provided it is large enough. Blocks can be 6- by 6-inch wood blocks, large rocks, a small amount of concrete, or concrete "bars" (such as used for car stops).

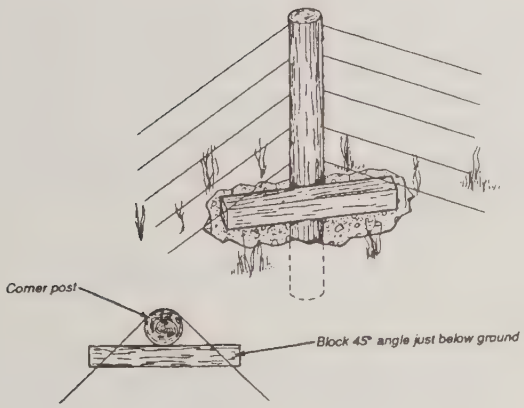


Post and Block Brace

Also the block can be placed away from the post and a compression spacer placed between the post and block. This compression spacer can be as long as necessary—6 or 8 feet, or even longer. The block brace can also, like the diagonal brace, be used effectively at dog legs or 90-degree corners to keep the post from pulling over. The block brace has a major advantage over the horizontal or diagonal brace in that there is no force trying to lift the post out of the ground.



Block Brace



Corner Block Brace

Summary

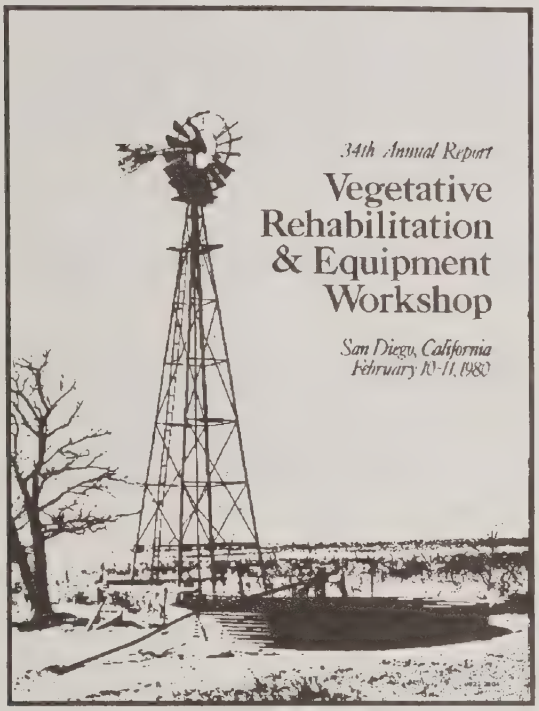
The horizontal and diagonal fence braces are equal in strength and holding power. A single horizontal or diagonal fence brace 11 feet long is equal to a double horizontal fence brace 16 feet long for a 4-foot high fence. In the design and installation of a diagonal fence brace several principles should be kept in mind:

1. Make the diagonal brace (as well as the horizontal brace) as long as possible.

2. Be sure the end of the diagonal in contact with the ground, is free to move in the direction fence pull, and is not blocked by a stake or fence post. This is important!

3. The diagonal brace can bear against the corner post in any location from the middle of the post up.

The block brace is a very good, low cost, easy to install, simple brace–but requires knowledge and judgment in where and how to use it.



1980
Vegetative Rehabilitation and Equipment Workshop 34th Annual Report

San Diego, California

The following abstracts have been taken from annual Vegetative Rehabilitation and Equipment Workshop reports from 1980 through 1989. The selection was made to show the scope and breadth of VREW related activities. For more information see the original article in the appropriate volume.

Arid Land Seeder

Carlton H. Herbel, Science and Education Administration, Agricultural Research Jornada Experimental Range, Las Cruces, New Mexico

The Science and Education Administration–Agricultural Research at the Jornada Range has demonstrated that more favorable conditions exist for germination and seedling establishment when uprooted vegetation is placed over seeded rangeland. The Agricultural Engineering Department at New Mexico State University, in cooperation with SEA-AR, designed and built the arid land seeder to create the micro-climate needed for seeding arid land. It was originally pulled by a crawler-tractor equipped with a rootplow. The seeder picks up the plowed brush from the ground, forms basin pits, firms the soil, plants seed, and then deposits the brush on the seedbed as cover.

In 1979, the arid land seeder was separated from the crawler-tractor and equipped with the rootplow. The rootplowing was done separately; the arid land seeder pulled by a large four-wheel drive tractor followed. This arrangement, rootplowing and seeding separately, was more efficient and faster.

The effectiveness of the mechanical treatment is being compared to chemical control with the herbicide tebuthiuron. The two methods are also being compared with an untreated area.

Seeding and Planting

J. Ross Wight, Science and Education, Administration–Agricultural Research, Northwest Watershed Resource Center, Boise, Idaho

Mr. Wight summarized the workgroup activities since the 1979 meeting.

A paper entitled "Automatic Bandoleer Feeder for Transplanters," by Modern and Brewer, was presented at the December 1979 meeting of the American Society of Agricultural Engineers. Work continues on the automatic feeding systems.

A Tye rangeland seeder mounted in front of a rangeland imprinter was used to seed 2,000 acres of rootplowed brushland in southwest Texas.

The Utah Division of Wildlife Resources continued to work with the rangeland interseeder and tree and shrub transplanter.

Disturbed Land Reclamation

Ron Younger, USDI-Bureau of Land Management, Salt Lake City, Utah

Jim Smith, professor, Department of Agricultural and Chemical Engineering at Colorado State University, Fort Collins, described a vertical-axis rotary tiller they are using.

Cal Kuska of Roscoe Brown Corporation described the operation of a pipeline backfilling machine that minimizes vegetation and soil disturbance.

Bob Knudson, project engineer at the Forest Service Missoula Equipment Development Center, gave an update on the sprigger for native shrubs, the small diameter water sampler, the dryland plug planter, and the dryland sodder.

Vertical-Axis Rotary Tillers

James L. Smith, Professor and Jon P. Workman, Research Assistant, Department of Agricultural and Chemical Engineering, Colorado State University Fort Collins, Colorado and Kent A. Crofts, Manager of Reclamation and Environment, Energy Fuels Corporation, Steamboat Springs, Colorado

This paper describes the vertical-axis rotary tiller and presents test results where the tiller was used for anchoring mulch and preparing a seedbed on topsoiled, recontoured mine spoil.

The vertical-axis rotary tiller produced superior results in field tests compared to the mulch crimper and horizontal-axis tiller. The vertical-axis tiller has many applications for reclamation and revegetation tillage and mulching. Redesign of some tiller components would improve their suitability for reclamation or revegetation work.

Minimizing Vegetation and Soil Disturbance in Pipeline Construction

Clavin Kuska, Roscoe Brown Corporation, Lenox, Iowa

A horizontal earth auger has been developed by Roscoe Brown Corporation that minimizes vegetation and soil disturbance along a pipeline right-of-way. The auger also minimizes damage to the anticorrosion wrap and the cathodic wires used to reduce failures from corrosion in the line. The auger requires only one-third the width that a dozer requires to perform a backfill operation and is 10 times faster than conventional shuttle backfilling with a dozer.

The auger is also effective in constructing berms and terraces, for borrow aeration, for removing silt from ditches, and for some grading.

The auger is hydrostatically propelled. Its speed can be set higher for shedding wet material and set slower for sandy and rocky conditions. The machine is simple in design and maintenance is minimal. The parts that wear (the replaceable and adjustable places on the leading edge of the auger) are under manufacturer's patent.

Equipment Development Projects For Disturbed Land Reclamation

Robert Knudson, USDA-Forest Service, Equipment Development Center, Missoula, Montana

The Equipment Development Center at Missoula is funded by the Bureau of Land Management for four projects related to disturbed land revegetation. A brief outline describes the problem to be solved, the project goal, prior work done, and project objectives. Discussed are: a sprigger for native shrubs; a small-diameter water-well sampler; a dryland plug planter; and a dryland sodder.

Mulching Machine Conversion From A Rotary Feed Grinder

Bob Anderson, Lo-Co Equipment Company, Windsor, Colorado

The need for a mulching machine capable of handling 1,500-pound bales of straw and hay motivated two mechanics at an Ohio coal mining company to modify a rotary tub grinder that normally is used for grinding cattle feed. The machine, called a Roto-Grind-Mulch Master, is now commercially available.

The Roto-Grind-Mulcher is a simple machine with two operating parts–the feeder tub or hopper and the beating machine. Mulching material is dumped into the hopper with a front-end loader. The mulcher handles large round bales, square bales and loose straw, and hay. Strings can be left on the bales. The mulcher will also spread bark, wood chips, composted municipal wastes, and all types of crop residues. Mulch is applied evenly and can be stopped from the tractor by stopping the tub.

One person can run the entire mulching operation if necessary, but two people increase efficiency–one person on the loader and one operating the mulcher. The unit requires a 100-horsepower tractor with a 1,000-rpm PTO.

Seed Harvesting

A. Perry Plummer, Chairman, Seed Harvesting Workgroup

Specialized equipment is needed to better harvest seed from plants in their native habitat. A successful seed vacuum harvester was built with two 6-inch hoses. The machine weighed about 1 ton, was mounted on a two-ton truck, and was custom built. A major handicap to the machine is that its use was confined to relatively flat land where a truck could operate.

In recent years the development and perfection of a backpack harvester has been underway, and some important progress has been made. Two of these machines have been manufactured. Additional changes are necessary to make them useable.

The Oklahoma State University grass seed stripper strips seed from the plants with a rotating drum with nylon flails. Because the seed canopy is not cut by a sickle, only a small amount of stems and leaves are taken into the harvester. This results in fairly clean seed. The unit is now commercially manufactured by the Kincaid Equipment Manufacturing Corporation, Haven, Kansas.

Steep Slope Stabilization

Lou Spink, USDA-Forest Service, Baker, Oregon

In 1979, at the request of the Willamette National Forest, the San Dimas Equipment and Development Center modified the steep slope seeder to be used either with a Gradall, as originally designed, or towed behind a tractor. The "towed" option was desired for seeding ski slopes. The modification also includes a set of pneumatic-tired wheels that can hydraulically lift the seeder so it can be towed on roads or other hard surfaces. This towing modification worked well at San Dimas. Data on its use will be gathered in 1980, and included in the next report.

The tree/shrub planter digs a hole with an auger, drops a seedling from a carousel-type container, and then compacts the soil around the planted seedling. To increase the planting rate, the planter was designed with two sets of planting equipment–auger, carousel and compactor–one at each end of the frame. However, the pre-prototype planter was equipped with only one set of planting equipment for demonstrating the concept.

The pre-prototype was tested on the Willamette National Forest in 1979. These tests showed that the concept was satisfactory, and further refinement is unnecessary. However, the final fabrication drawings for the "double" planter were not completed by the end of FY 1979, and no funds were allocated for this project in FY 1980. No work will be done or planned on this project until funds are available.

Assessment of High Voltage Electricity For Brush Control

Thomas H. Shrader, Water and Power Resources Service, Rio Grande Project, El Paso, Texas

To obtain better control without chemicals and soil-damaging mechanical methods, the Rio Grande Project of the Water and Power Resources Service (formerly Bureau of Reclamation) contracted with a private company during 1977 to demonstrate the potential effectiveness of high voltage alternating current (AC) to control woody plant species.

In addition to growth-stage and species, other variables in the evaluation of the ac systems were application speed, number of passes over the same plants, voltage delivered to the plants, and power density. Combinations of these variables were used to evaluate treatments. Check plots were mowed for comparison.

Based on a visual evaluation of both treatments, the high voltage ac treatments, except for the kill of a few young and solitary seepwillow plants, caused results that were comparable to an effective searing with LPG. Of the variables evaluated, the combination of application speed (greater treatment time), high voltage, double passes (two passes over a plant in opposite directions), thin stands of vegetation, and young succulent growth resulted in the most complete top kill of saltcedar, mesquite, screwbean, and older, denser stands of seepwillow plants that received the full or nearly full dosage of the ac charge. Established plants of the four species resprouted and displayed normal growth following the death of treated foliage and branches.

The high voltage treatments were least effective in dense homogeneous or mixed stands of the species and in individual, dense, shrubby plants.

Madge Rotoclear Machine

William E. (ed) Dick, Sales Manager, Can-A-Mex Manufacturing, Limited, Calgary, Alberta

Can-A-Mex Manufacturing, Limited, of Calgary, Alberta, manufactures a heavy-duty rototiller and land clearing machine called the Rotoclear. The Rotoclear is powered by

a 365-horsepower diesel engine and weighs 21,000 pounds. It is not self-propelled and must be pulled by a D-6 size crawler-tractor or large-wheeled tractor such as a John Deere 540 log skidder. The treatment width is 17-1/2 feet and the machine can mulch to a depth of 9 inches.

As a rule of thumb, if material can be cut with an ax, the Rotoclear can mulch the material. When clearing land, trees up to 5 inches in diameter do not have to be removed or cut before mulching. The Rotoclear has also been used to grind soap stone lime for fertilizer and grind volcanic rock for construction applications. The machine is not designed to crush rock, but if rock is encountered, it will not hurt the machine. It will cause more rapid teeth wear, however.

Dryland Sodding–A Summary

Jane Bunin, *Science Application, Incorporated Boulder, Colorado and Joann T. Hackos, Colorado School of Mines, Golden, Colorado and Michael Harthill, Water and Power Resources Service, Denver, Colorado*

Dryland sodding (DLS) may prove a useful reclamation method for sites that show unsatisfactory results with seeding or have serious erosion problems.

The authors define sodding as a reclamation method in which a unit of soil and its associated vegetation is removed intact from an area about to be mined, transported to a mined area readied for revegetation, and redeposited intact on graded and suitably prepared soil. The method is further labeled dryland sodding because no irrigation is required past the initial week of establishment.

Biological and environmental factors favor the use of DLS. However, current economic and logistical considerations may make DLS far more expensive than seeding in terms of direct initial costs. On the other hand, if indirect or delayed costs are taken into account, DLS may still prove advantageous.

New Prescribed Burning/Backfiring Tool Tested In Brush

Denny Bungarz, Fire Management Officer, USDA-Forest Service, Mendicino National Forest, Willows, California

The helitorch, a backfiring device slung under a Bell 206B helicopter, was tested by USDA Forest Service Personnel on the Grindstone Chaparral Management Area, March 21 to 24, 1979.

The helitorch originated in Canada. Western Helicopter Services, Inc., of Newberg, Oregon, improved the design and added the gelled fuel concept, with the assistance of the Forest Service Missoula Equipment and Development Center. Improvements in the original design include mixing fuel thickener with gasoline, which forms a flammable substance the consistency of unset gelatin.

The helitorch consists of an aluminum frame that holds a 55-gallon barrel, a small electric motor that drives a small positive displacement gear pump, and an ignition device The pump and ignition source are activated by a switch controlled by the pilot.

This tool has definite applications for prescribed burning. It will allow land managers to burn in wet weather. Difficult areas to reach are accessible to the helitorch. This tool should allow land managers to burn when smoke dispersal is good and should increase the acres-per-day of burning.

Its application for backfiring is also excellent. Accessibility is almost unlimited. If a land manager needs a great amount of heat to cause a wildland backfire, the helitorch should do the job.

Rare Plant Propagation

Phillip L. Dittberner, Plant Ecologist, Fish and Wildlife Service, Fort Collins, Colorado

Numerous authors have written papers related to threatened and endangered plants. Suggested management activities included:

1. Compiling an inventory of threatened and endangered species and their habitats;

2. Establishing refuges for protecting populations of threatened and endangered plants and their habitats;

3. Implementing special environmental practices that may be used in managing endangered plants and their habitats; and

4. Identifying techniques for propagating or growing and producing threatened and endangered species under cultivated conditions.

There are three major areas of information and research needs for rare, threatened, or endangered species. These include developing:

1. Complete understanding and descriptions of life histories;

2. Complete descriptions of habitat requirements; and

3. Complete population dynamics pictures for each species.

Additionally, distinction needs to be made between "reintroduced" and "introduced" plants in a habitat.

The state-of-the-art for propagating, growing and managing rare, threatened and endangered plant species is very immature. Few people have done research on these topics. Some examples of this past research are discussed.

By carefully examining the management strategies and expanding research programs relating to threatened and endangered or rare plant species, we can increase our resource management options in many areas. We may also find that there are special equipment needs for germination, planting, and maintenance of some of these populations.

What's New In Seed

Art Armbrust, Sharp Brothers Seed Company, Healy, Kansas

Mr. Armbrust lists the primary sources for new varieties of seed and germplasm, the primary areas of private breeding efforts, and some areas of public practical breeding efforts. Thirty-two new varieties of conservation plants cooperatively released through the Soil Conservation Service (SCS) are listed as well as proposed releases by SCS plant materials centers in the years 1980-85.

Mr. Armbrust also discussed some ramifications as SCS looks into the possibility of transferring some or all of the plant materials program activities to non-federal control.

New Forage Plants for Rangeland

Douglas R. Dewey, Research Geneticist Science and Education Administration–Agricultural Research, Logan, Utah

During the past five years, a five-scientist, USDA-SEA-AR range-forage improvement team has been assembled at Logan, Utah. The team includes a plant cytogeneticist, a plant physiologist, two plant breeders, and a range scientist.

This paper focuses on two aspects of the range-forage improvement project at Logan:

1. The recent introduction and description of new range-forage germplasm from the USSR; and

2. The development potential of new grass species arising from wide hybridization.

Using Solar Energy in Range Watering Systems

Charles E. McGlothlin, Range Staff Officer, USDA-Forest Service, Custer National Forest, Billings, Montana and Roy Lockhart, USDI—Bureau of Indian Affairs (retired), Albuquerque, New Mexico

This report describes the first solar-powered water well built in the US for livestock at the Isleta Indian Reservation near Albuquerque and a similar project installed near Roswell, New Mexico. Advantages and disadvantages of the systems are given.

Chaparral Vegetation Management Alternatives

J. L. Hickman, Program Manager, Chaparral Vegetation Management R & D Program, Pacific Southwest Forest and Range Experiment Station, Riverside, California

Chaparral-covered lands are highly productive. Chaparral vegetation constitutes tons of bio-mass, is important as wildlife habitat and as productive rangeland, has esthetic value, and is also a potential source of energy.

Protection is the objective in managing chaparral lands. Management must realize the vegetation production potential and prevent catastrophic fires. In general terms, managers of chaparral lands have four treatment choices for developing a manageable mosaic of even-aged stands of vegetation:

1. Protection;

2. Changing the density, species composition, and/or age class;

3. Type conversion; and

4. Removing all vegetation to bare soil.

Tools for accomplishing these tasks can be grouped in four treatment areas:

1. Mechanical;

2. Chemical;

3. Biological; and

4. Fire.

Mr. Hickman summarizes treatment choices and methods and comments on the idea of using chaparral as a potential energy producer.

Mine Reclamation Costs And Systems

Michael J. Cwik, President, Intermountain Resources, Limited, Spokane, Washington

Accelerated mineral production at a time when restrictive environmental statutes and regulations are being passed has placed the miner in the position of having to be environmentally accountable for mineral exploration. As a result, the mining industry is asking two basic questions:

1. "What can be done to rehabilitate the surface of my mine in a way that will be consistent with environmental regulations promulgated by jurisdictional authorities?"; and

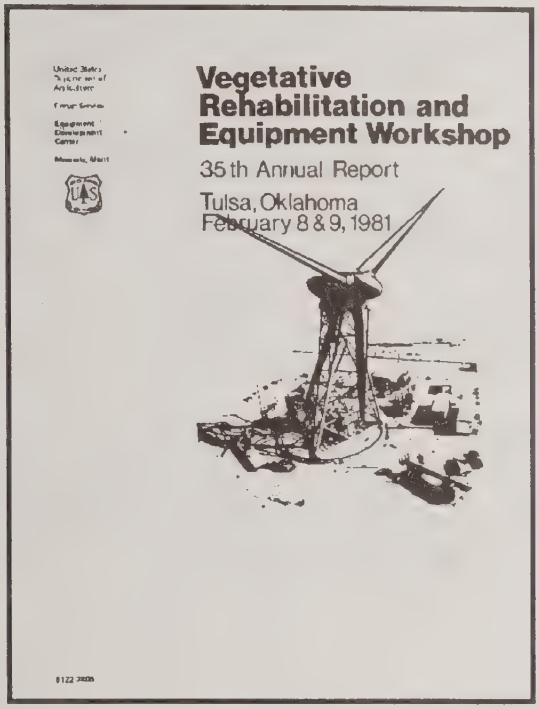
2. "How much will this reclamation cost?"

Current available research has resulted in a warehouse of data on surface stabilization. The careful review and interpretation of this data can support experienced judgment on recommended and defensible methods of landscape rehabilitation.

The little available data on surface stabilization costs usually appear in costs-per-acre. Reclamation costs discussed in this article segregate mine reclamation into four general practices: earth moving, earth shaping, cultural inputs, and vegetation planting.

Research on costs in all reclamation fields, and particularly in the area of acquiring and operating reclamation equipment is needed so the mine reclamation plan interface can allow meaningful decisions in extracting and processing vitally needed fuel and non-fuel mineral resources.

A reclamation "schematic" is also presented.



1981
Vegetative Rehabilitation and Equipment Workshop
35th Annual Report

Tulsa, Oklahoma

Truax Native Grass Drill

Jim Truax, Truax Company, Minneapolis, Minnesota

The Truax native grass drill was designed to fill the need for a dependable, continuous-duty grass drill to plant the fluffy native grasses, as well as the smaller legumes and similar seeds. This was accomplished by structuring the drill design in such a way as to achieve ideal soil-to-seed contact of even the most difficult to handle seed.

The Truax drill is also designed to be used either on a three-point hitch or as a tongue drill by removing a single pin. An optional third seedbox is available that is designed to handle all the cereal grains and wheat grasses. This unit is clutched and driven separately from the other two boxes.

One-Operator Mulching System

Bob Anderson, Lo-Co Equipment Company, Windsor, Colorado

The Lo-Co Equipment Company has just completed field trials of a new one-operator mulching system. This system, which is operated from a standard farm tractor, allows one person to spread mulch at the rate of one 1,500-pound bale every five minutes. The system has a low initial cost (under $5,000).

Two hydraulic controls (the system can be operated with just one) are required. One hydraulic control lifts and loads the round bale, the other hydraulic control unfolds the bale and moves mulch to the flails (powered by PTO), which break it up and throw it out. This machine uses less horsepower than the tub rotogrind mulcher because there is less mulch reduction.

The system, when using the round bale, allows the operator to remain seated on the tractor while loading the bale and controlling the direction (up or down) of throw.

Mechanically Harvesting Plains Pricklypear Cactus For Control And Utilization

Dennis M. Mueller, Science and Education, Administration–Agricultural Research, Fort Collins, Colorado

Plains pricklypear cactus (Opunta polyacantha L.) is locally abundant on the Central Plains. Harvesting studies indicated dry matter yields up to 1,600 pounds per acre. Pricklypear is undesirable because it is a barrier that prevents cattle from grazing a considerable portion of the herbage. However, chemical analysis and feeding trials at

the Central Plains Experimental Range showed that plains pricklypear is highly nutritious and relatively palatable when the spines are singed.

The possibility of simultaneously controlling and feeding plains pricklypear led to development of harvesting and spine removal machinery because hand methods are extremely time consuming.

A front-mounted International Harvester No. 8 high-speed, side-delivery rake was modified to uproot and windrow the pricklypear with little turf or soil disturbance. Design and prototype work is underway on equipment to pick up and singe pricklypear after it is windrowed.

Transplanting Using The Bandoleer Concept

Victor Hauser, Science and Education Administration–Agricultural Research, Grasslands Soil and Water Research Laboratory, Temple, Texas

Establishing grass from seed is often unsuccessful in the Southern Plains and other areas. A new grass establishment method is being investigated by the Science and Education Administration–Agricultural Research (SEA-AR) at Temple, Texas. Instead of planting seeds directly in the field, grass plants are produced in the greenhouse and transplanted to the field. The system is based on the bandoleer concept devised by H. L. Brewer. The bandoleer is made of plastic and has pockets much like those in a machinegun bandoleer. Young grass plants are grown in the pockets under optimum conditions in the greenhouse. The growing medium, seeds, and young plants are readily available for machine handling at all stages of growth and during transplanting in the field. The planting dibbles of the SEA-AR transplanter were adapted from a transplanter developed by the Forest Service.

Development Of A Rangeland Interseeder For Rocky And Brushy Terrain

Dan W. McKenzie, Mechanical Engineer and Range Scientist, USDA-Forest Service, Equipment Development Center,San Dimas, California and Richard Stevens, Utah Division of Wildlife Resources, Ephraim, Utah and Walter L. Moden, Jr., University of Idaho, Moscow, Idaho

This report focuses on an effort by the Forest Service San Dimas Equipment Development Center to develop a demonstration interseeder that could operate in rocky and brushy terrain. A five-component interseeder was developed in 1977. Over the past three years the interseeder has been tested near Ephraim, Utah, and near Boise, Idaho; modifications to the device have been made as needed.

Also presented in this report are descriptions of the equipment and details of the approach used to test the feasibility of transplanting shrubs to improve range habitat.

Arid Land Seeding

Carlton H. Herbel, Science and Education Administration-Agricultural Research, Jornada Experimental Range, Las Cruces, New Mexico

A newly designed grubbing blade developed for front-mounting on a rubber-tired tractor and patterned after the low-energy grubber's blade (crawler-tractor) appears very promising for controlling junipers 2 to 5 feet tall. Preliminary data indicate only a slight reduction in acre-per-hour performance. The total investment will be approximately one-half. Fuel consumption is 72 percent less than that of a crawler-tractor.

Tests in 1979 compared disk-chaining to smooth chaining for low-cost seedbed preparation on rough, log-littered, rootplowed rangeland where heavy-duty offset disks and grass drills would have been unable to operate successfully. Several types of chains were tested. Results of disk-chaining follow more closely the results of offset disking but costs and energy use appear to be reduced half.

Plant Materials

Wayne Everett, USDA-Soil Conservation Service, Washington, D.C.

The Plant Materials Workgroup has revised its committee membership, developed 1980-82 objectives and activities, and initiated development of a cultivar source listing of plants currently recommended for range, critical areas, and reclamation plantings.

The plant materials program has been funded and retained as an SCS program with provisions for maintenance and replacement of equipment and facilities for FY 1982.

Tables are given listing the SCS cooperative cultivar releases to December 1980 and the commercial seed and plant production of these releases to July 1979.

Need To Develop Alternative Methods To Judge Revegetation Success

Ken Brakken, ERT, Incorporated, Fort Collins, Colorado

The coal industry is currently experiencing a difference of opinion with the Office of Surface Mining (OSM) over parts of Federal coal mining regulations. The controversy is over methods of judging success of revegetation prior to bond release of reclaimed coal mined lands. Public Law 95-87 was signed into law August 1977. Two sets of regulations were promulgated to implement the law. Regulations allow the use of reference areas or technical standards published by the US Department of the Interior or Agriculture. Since there are no published USDI or USDA technical standards that can be immediately applied to judging success of revegetation on surface mines, there is now only one OSM-sponsored method to evaluate revegetation reference areas.

The law and regulations permit post mining land-use changes to higher and better uses. In this case, different vegetation types would be substituted for those previously existing, and a pre-mining reference would not be appropriate since a change in vegetation would be intended.

An ad hoc committee, the Committee to Develop Alternative Methods to Judge Success of Revegetation of Coal Mined Lands, has been formed. Observations and suggestions have begun. Committee participation is solicited.

Inoculation Of Tubelings With Mycorrhizae To Aid Plant Establishment

Claire Gabriel, Native Plants, Incorporated, Salt Lake City, Utah

Most native plants have adapted to growth on low-fertility soils through a mutually advantageous association with certain beneficial soil fungi, called mycorrhizae. The fungus obtains an energy source from the plant in the form of fixed carbon, and the plant may benefit from enhanced soil uptake of phosphorus. These advantages invariably yield increased plant growth and survival.

Soil disturbances resulting from severe erosion, long-term clearing, topsoil stockpiling or fumigation can reduce the natural complements of mycorrhizal fungi in soils. Revegetation can be slowed, unless efforts are made to reintroduce and manage these important microbes.

Transplant Machine For Transplanting Vegetation

James L. Smith, Professor and John P. Workman, Research Assistant, Department of Agricultural and Chemical Engineering, Colorado State University Fort Collins, Colorado and Kent A. Crofts, Manager of Reclamation and Environment Energy Fuels Corporation Steamboat Springs, Colorado

A study was made concerning the productivity of a front-loader used to transplant approximately 60,000 square feet of mature vegetation. The vegetation was transplanted in pads using a modified front-loader bucket with an effective area of 75 square feet.

Analysis indicated that over 80 percent of the time involved in transplanting was used to travel between the plant source and the transplant area. It was evident that transporting costs could be significantly reduced and production increased by a machine to transplant and place several pads of vegetation in a single trip.

An experimental transporter was fabricated by modifying a Hesston Model 20 Stackmover. Two modes of operating the transporter were evaluated. In general, operation of the transporter was very satisfactory. Suggested improvements are given.

Land Reclamation Methods And Plant Materials For Arid Sites

C.M. McKell, Logan, Utah and Gordon Van Epps, Utah State University, Ephraim, Utah

Disturbance of harsh sites in the arid southwestern United States requires methods and plant materials unique from those employed in areas of more favorable climate. The authors' work at the Henry Mountain Coal Field in southcentral Utah and on a processed oil shale disposal pile at Anvil Points, Colorado, features the use of container-grown plants to avoid the hazards in establishing seedlings and growing plants in a topsoil-filled trench in the shale disposal pile. Greatest success is experienced with plant species adapted to drought, salinity, and wide temperature extremes. Some of the most favorable species tested were Atriplex confertitolia, Atriplex coneata, Kochia prostrata and Elymus junceus.

A Reclamation Contractor's Experiences With Equipment

Don Calhoun, D & C Reclamation, Lander, Wyoming

D & C Reclamation performs contract revegetation work for mining companies, oil companies, pipeline contractors, highway contractors, and private landowners. Mr. Calhoun describes his positive and negative experiences with the rangeland drill, the Hodder gouger, the hydroseeder, the Case Skidster, and various backhoes.

Disturbed Land Reclamation (Eastern "Sub" Group) Report

Willis Vogel, USDA-Forest Service, Berea, Kentucky

This report discusses some concerns with establishing woody plant species on surface mined lands in the eastern United States and speculates on the needs for equipment and procedures that may be helpful in establishing woody plants.

Several actions are needed to improve chances of successfully establishing and growing woody species, including changes in those earth-moving practices that obviously hinder survival and growth of seedlings, and developing new techniques for successfully establishing woody plant seedings.

The author believes existing seeding equipment, with modification where necessary, can be successfully used for most of the applications on surface-mined lands. In most situations that require specialized equipment, it is first a matter of informing potential users and agencies that advise the users that equipment suitable for reclamation work exists and is available. In some cases, users must be informed that plans for construction are available. In some situations VREW participants may be able to help a potential user borrow and test an appropriate piece of equipment.

Seed Harvesting

Stephen B. Monsen, USDA-Forest Service, Boise, Idaho

Field testing has been conducted to evaluate three new seed collectors. These hand-operated units are designed to harvest seed from native plants in the wild. All three machines use a vacuum to extract and collect seeds.

Machines tested included an injector seed-collecting head (air amplified) powered by a trailer-mounted air compressor constructed by the San Dimas Equipment Development Center; an adapted version of a commercial back-pack type air-blower built by Solo Kleinmotoren Company of West Germany, and a 370-pound gasoline-powered Elephant-Vac marketed by Evans Sales and Marketing, Inc. Successful applications as well as drawbacks of each machine are discussed.

Adaptation Of The Steep Slope Seeder For Mine Land Reclamation Work

John Graves, Native Reseeders, Windsor, Colorado

The method of using a Gradall steep slope seeder was too expensive for Mr. Grave's operation as a mined site reclamation contractor in Colorado and Wyoming. The modification made for towing the unit made by the San Dimas Equipment Development Center did not work with contractor-owned equipment. The contractor also believed several changes were necessary to work on the tougher sites of Colorado and Wyoming.

Changes made by the contractor are:

1. A two-point hydraulic over-cable hitch was made to adapt the seeder to use on the contractor's D-2 Caterpillar tractor;

2. The rake assembly was changed to use Danish S cultivator tines for easier replacement and to open crusted soils;

3. The packer wheel arms were beefed up by building them with three-inch channel iron instead of the specified strap steel;

4. Finger weeder tines were used to support the conveyor chain drags; and
5. The wheel hubs of the original design were not readily available, so they were replaced with automotive hubs bolted on the front frame leg.

These changes met the majority of the contractor's needs. He would also like to see the installation of an articulation device for continuous towing use where the orbital hydraulic motor is normally mounted to benefit the seeder.

Thermal Plant Control

Bill Davis, USDA-Forest Service, Ogden, Utah

The helitorch is a reliable aerial ignition system for setting prescribed burns and controlling wildfires. The helitorch uses gasoline thickened into a gel by a powder similar in

texture to laundry detergent–either Alumagel or military fuel thickener. Unlike gasoline-diesel fuel mixtures, which tend to burn out or break up before reaching the ground, the gelled gasoline holds together and keeps burning as it falls through the air.

The helitorch consists of a 55-gallon barrel, igniter, and electric pump that pumps out the gelled gasoline. The helicopter pilot controls the flow and ignition of the gel. The new gel enables pilots to drop fire with greater accuracy from higher altitudes and faster speeds, which increases safety and efficiency.

Fire on the ground can be obtained from a height of 200 feet at an airspeed of 40 mph. This produces burning gel/gasoline globules the size of golfballs that burn 8-to-10 minutes.. Drop heights of 150 feet and airspeeds of 30 mph produce burning globules the size of baseballs with a burn time on the ground of 12 to 17 minutes.

Operations within prescribed burning windspeeds will not affect the drift of gelled gasoline during ignition.

Rangeland Use Of The Mercedes Benz Unimog

Loren Brazell, USDI-Bureau of Land Management, Reno, Nevada

The Unimog is a versatile diesel-powered, all-terrain vehicle that BLM has used year around in Nevada for fire suppression, and by force account work using a backhoe attachment and a dozer blade.

As a firetruck, the Unimog will out perform a standard four-by-four firetruck. It will traverse rougher terrain with less vehicle damage because of high ground clearance and low operating speeds. When equipped with a backhoe and dozer blade, the Unimog can be used for digging soil pits or performing range development work. Advantages of the Unimog include the ability to traverse rougher terrain than a farm-type tractor and to travel at highway speeds up to 40 mph for rapid movement between work areas.

Disadvantages of the Unimog include: Mercedes Benz dealers are the only suppliers of equipment and parts; parts are not readily available, and an inventory of parts must be kept on hand; the two-person cab is too small to carry firefighting crews; and the highway speed of 40 mph is too slow for long distance movement considering the truck must be used for distances of more than 150 miles.

Methods Of Mechanical Plant Control At The Energy Fuels Mine In Northwest Colorado

Kent Crofts, Range Scientist, Energy Fuels Corporation, Steamboat Springs, Colorado

Regulations issued by the Office of Surface Mining under 30 CFR 816.22 require that all vegetative material that might interfere with the use of topsoil shall be removed before topsoil removal. Attempts at resolving the problems of disposal of the woody vegetation cleared ahead of the surface mining operation resulted in less than satisfactory outcomes.

In 1980, a Madge Rotoclear machine was ordered. Mechanically and operationally the machine performed well. The mechanical components of the machine are proven and dependable. Some minor modifications are necessary to improve the machine. Operational limits as to the slopes the machine will effectively treat are limited only by the slope a dozer can traverse. Analysis of cost data reveals an immediate savings of operating the Rotoclear over using a production dozer average $444 per acre.

Range Water Systems Improvements

Dan W. McKenzie, Mechanical Engineer and Range Scientist, USDA-Forest Service, Equipment Development Center, San Dimas, California

The project goal is to improve range water supplies and systems for pumping and handling range water. The objectives are to:

1. Investigate and develop systems for preventing stock watering tanks from freezing; and

2. Investigate and develop solar water pumping systems as alternatives to the standard windmills.

Mr. McKenzie summarily addresses circulation systems, a propane bubbler, the Walden Pondmaster, mass insulating systems and solar systems for preventing freezing.

Summarized also are three categories of equipment that offer potential for improving range water pumping systems:

1. Photo-voltaic-powered systems;

2. Solar-thermal powered systems; and

3. Improved or new windmills.

BLM's Equipment Development Program For Revegetating Disturbed Lands

Richard Hallman, Range Program Leader, USDA-Forest Service, Equipment Development Center, Missoula, Montana

In 1975 MEDC personnel began working with the Bureau of Land Management (BLM) to develop equipment and techniques to revegetate lands under arid and semiarid conditions where establishing vegetation is difficult and expensive. Six pieces of equipment were eventually built to accomplish six specific revegetation tasks. The six pieces described are: the dryland plug-planter, the tree transplanter, the dryland sodder, the sprigger, the basin blade, and the modified Hodder gouger. Function, description and specifications for each is given.

Forest Service Equipment Development Center Activities

Ken Dykeman, USDA-Forest Service, Equipment Development Center, San Dimas, California and Richard Hallman, Range Program Leader, USDA-Forest Service Equipment Development Center, Missoula, Montana

A review of current activities of the Equipment Development Center activities were presented. Those reviewed are: an intermittent, containerized, and bareroot tree planter; a hill-climbing machine; a forestland residues machine; a tree shaker for western conifers; cone-and-seed collections system; a reefing system for cargo parachuting; a lightweight cable yarder; a mini cable yarder; a rock rake; a planting-handtool study; a mechanical nurserybed thinner; a hand thinner; aerial spraying effectiveness; a spawning gravel cleaner; and a tree planting slide/tape.

Sun-Powered Water Pumping

Kenneth A Ude, ARCO Solar, Incorporated, Chatsworth, California

This is a summary on solar electric power, specifically water pumping, now under development by ARCO Solar, Incorporated.

The major components of a solar water pumping system are the solar array, the electric motor, and the pump. Centrifugal water pumps can be directly connected to the solar array with no battery or electronics. When batteries and controller are added to the system, the motor is allowed to operate at a relatively constant rpm. This means that when the system operates, you are guaranteed water, or if you have a positive displacement pump, you can overcome the initial high starting torque.

ARCO Solar believes the most cost-effective approach is to use a small amount of battery storage and a controller that allows the system to operate about the same number of hours per day as peak sunlight hours. It is also more economical to store water than it is to store electricity. So in the system design, ARCO tries to pump all the water that is needed for a 24-hour period during peak daylight hours and store it in an elevated tank, then allow gravity to supply pressure to the application.

Because solar cells are still expensive, today application areas must be picked carefully. The major components that effect the cost effectiveness of the system are sunlight and the availability of fuel maintenance.

Solar Photovoltaic Irrigation Pumping Plant

Neil Sullivan, Thomas L. Thompson and P. E. Fischback, Agricultural Engineering Department, University of Nebraska, Lincoln, Nebraska and Ray F. Hopkinson, Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Massachusetts

The direct current output of a 25-kW (kilowatt) peak output 520m^2 photovoltaic array was used to run an irrigation pump for a 32-ha cornfield. The battery storage requirements for different methods of pump operation were compared. With 30 kW/h of power storage, constant load operation of the pump was able to utilize over 90 percent of the power produced by the array for irrigation. On clear days the step-load operation of the pump could reduce the battery strait requirements of the system to less than 2 kW/h, but up to 20 kW/h of storage was required to operate the pump with step-loading on cloudy days. However, when the power storage was reduced, the step-load operation could use only 60 percent of the power produced by the array. Of the remaining 40 percent, 33 percent was dissipated in the power dump and 7 percent was lost in reduced system operating efficiencies.

Reclamation Techniques

Allan M. Hale, Dames & Moore, Cincinnati, Ohio

In any discussion of reclamation technology, a thorough understanding of the specific nature of the individual site problems is the key to successful rehabilitation efforts. Distinctly different reclamation techniques are used when reclaiming active or abandoned mined lands. This

discussion gives an overview of some of the major problem areas, limiting factors and reclamation techniques that have been successful.

Harnessing The Wind For Irrigation Pumping

R. Nolan Clark, Science and Education Administration-Agricultural Research, Bushland, Texas

A wind energy project for irrigation pumping was started at USDA-SEA-AR, Conservation and Production Laboratory, Bushland, Texas, in 1977. The pumping system uses both a wind turbine and an electric motor to power a conventional vertical turbine irrigation pump. The electric motor is sized to operate the pump on a stand-alone basis and runs continuously. The wind turbine is coupled to the pumping system through an over-running clutch and combination gear drive, and furnishes power to the pump only when the windspeed exceeds 13 mph. When the wind turbine operates, it reduces the load on the electric motor, rather than replacing the motor.

The wind-assisted pumping system effectively utilized the unsteady power output of the wind turbine. The system has operated satisfactorily, and the concept has proved to be sound. All components are readily available and proven, and the mechanical drive is simple. The over-running clutch has proved to be a simple and reliable method of synchronizing the two power sources.

The wind-assisted concept can be used in any rural or remote area where a second power source is available. Practical use will depend on whether wind energy is more economical than existing energy sources.

Wind Energy–An Industrial Perspective

Gene C. Valentine, Windfarms, Limited, San Francisco, California

Windfarm Limited has a goal to demonstrate the feasibility, through application, of wind technology. Mr. Valentine gives a history of the development of Windfarms, from concept through steps required to establish an 80-megawatt wind farm for the Hawaiian Electric Company.

Seed Production Techniques

Robert M. Ahring, Science and Education Administration–Agricultural Research, Stillwater, Oklahoma

Seed from good forage grasses is very difficult to produce and seeds that produce well often present unique and difficult harvesting problems. High seed yields can be achieved with many grasses with the proper combination of variety (strain or species) with environmental and agronomic practices (cultural, management, and harvesting). Much more is known of growth and crop development of the cool-season grasses than of warm-season grasses. The influence of the physiological processes associated with the complex relationships of environmental and genetic factors and cultural conditions on crop seed yields need to be determined. Optimum combinations of these factors are fundamental to establishing grower-efficient seed production techniques.

Kincaid Grass Harvester

Delmar Kincaid, KEM Corporation, Haven, Kansas

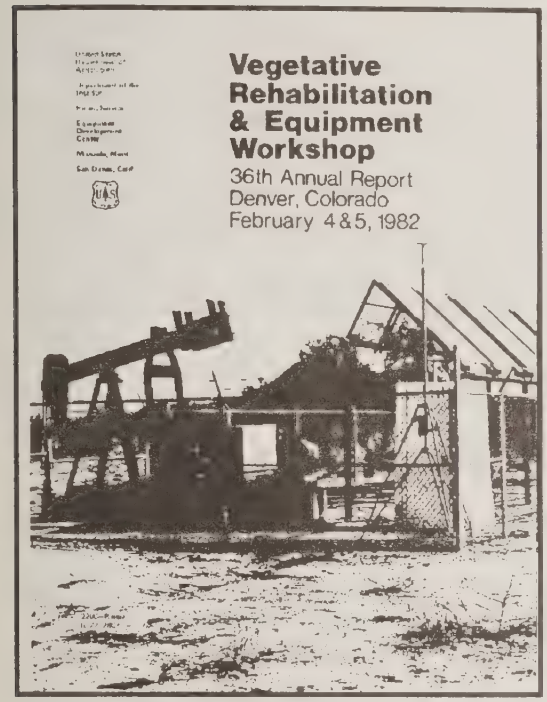
Continuous testing has been done on the grass harvester designed by Oklahoma State University. Improvements to the harvester inciude a mechanical bagging system with a "y" discharge, so bags can be changed while harvesting. An extended hood has also been added to decrease seed loss.

Purity of seed can be affected by header height, reel speed, and forward travel. By achieving the correct ground speed and reel, very little unripened seed is removed from the grass stalk, and unwanted debris is left on the field. Ground speeds of 4.5 mph were used and the results were acceptable. Seed purity and seed removal were well within the expected range.

Other advantages of the harvester include:

1. It is less expensive than the conventional means of harvesting;
2. It is easy to transport, set, and clean out; and
3. It can normally cover more acres and harvest at higher moisture levels than a regular combine.

Grasses that have been harvested with successful results are: little bluestem, big bluestem, side oats Grama, indiangrass, Old World bluestem, caucasian bluestem and buffelgrass.



1982 Equipment Workshop 36th Annual Report

Denver, Colorado

Examining VREW's Mission

Ted Russell, USDA-Forest Service, Washington, D.C.

During the formative meetings of the Reseeding Equipment and Development Committee (1945), the functions of the group that would eventually become VREW were outlined. The committee would consider, evaluate, and assign priorities to the equipment problems that were suggested for attention by several Forest Service Regions, and each year they would draw up a program of work for the Equipment Laboratory to follow. Additionally, the committee would draw up specifications for the most desirable makes and models of equipment to be used in range reseeding.

In 1949, the purpose of the committee was enlarged to keep abreast of commercially developed equipment and to develop equipment not commercially available.

Private Industry's Viewpoint of VREW Equipment

Kent A. Crofts, Range Scientist, Colorado Yampa Coal Company, Steamboat Springs, Colorado

A straw poll concerning revegetation equipment knowledge of the reclamation representatives from 21 coal mines in six western states was conducted by the author. While there were inherent weaknesses with the poll, it was a valuable starting point to quantify the viewpoint on VREW equipment

There were some surprising findings in this poll. Approximately three-fourths of those polled initially learned about VREW from the Society of Range Management (SRM). It might be appropriate to strengthen the ties between VREW and SRM and broaden the foundation upon which VREW has evolved.

The second finding deals with the reluctance on the part of the industry reclamation specialists to utilize most of the recently developed pieces of equipment. Two interesting points are raised by this finding: there is a need for new reclamation equipment; however, any future development of new equipment must have more input from the user group if it is going to be accepted by those responsible for using the equipment.

How Do We Market Products Of VREW? (from manufacturer's viewpoint)

John Laird, Laird Welding and Manufacturing Works, Merced, California

Special-use equipment causes problems for the manufacturer because of the low volume of sales. The ability of a manufacturer to produce a product at a

reasonable price with a low unsure volume is difficult to achieve. Problems include warehousing minimum orders necessary for parts, finding multi-skilled workers, advertising and technical literature costs, difficulty with bank letters of credit, and overseas freight prices.

Small manufacturers have to rely on, and make use of, the Forest Service Equipment Development Center's technical output and guidance in research and development. The necessity for the Development Centers to perform this function is vital to VREW and the small manufacturer. Without it, specialized revegetation equipment would be too expensive for the users, and the small manufacturer would not make this type of equipment.

Lely Vertical-Axis Tiller

Bill McGinnies, USDA-Agricultural Research Service, Fort Collins, Colorado

Tests of the Lely vertical-axis tiller have continued in Colorado and Wyoming. James L. Smith, University of Wyoming, has attached ripping-teeth ahead of the tiller and found that this improves efficiency considerably, particularly in hard ground. In Colorado, W. J. McGinnies has been using the Lely vertical-axis tiller to incorporate mulch. For effective mulch incorporation, the front of the tiller must be raised to give the tilling tines a down-and-into-the-soil action. The tiller will incorporate 1,000 pounds per acre of straw or hay mulch in one pass, but for 3,000 pounds per acre, two passes were required. Shear pin breakage was encountered when buried logs (left by a Rotoclear tree shredder) jammed the tines. Lely manufactures an automatic shear pin replacer and one of these has been obtained for testing.

The vertical-axis tiller produced better seedbeds than the more conventional horizontal-axis tillers or seedbeds prepared by the plow-disk-harrow procedure.

Development Of An Articulating Planter For Seeding Rough Lands

Jim Truax, Truax Company, Minneapolis, Minnesota

To achieve proper planting on the typical disturbed, contoured site laden with rocks and other debris, the Truax Company has under development an articulating planter that folds and bends with the contour as it is pulled across the site. The seedboxes, seedbox agitators, and seed-metering devices are the same as those on the standard Truax drill. Field cultivators or chisel plows replace the double disk-openers. In place of the seed tubes, rubber belting is used to guide the seed to the ground from the seedbox. A rolling harrow or drag is used to cover the seed. The seedboxes, chisel plows, rubber belting, and rolling harrow are all carried by an articulating frame. This results in uniform depth control, constant ground contact of the seedbox drive wheel, and elimination of "bottoming out" when crossing swales and other sharp contours.

High Rate Mulch Spreading Equipment

Bob Anderson, Lo-Co Equipment Company, Windsor, Colorado

The Lo-Co Equipment Company has two models of high-rate mulch spreading equipment for sale, lease, or custom mulch spreading–the Mulch-Master and the Big Bale Buster.

The Mulch-Master is a modified arm tub grinder that will spread any type of mulch or mulch bale as well as loose material such as bark and wood chips. The machine works from the power takeoff (PTO) of the towing tractor and requires a tractor of at least 100 horsepower.

The Big Bale Buster is a self-loading machine, powered by the towing tractor's PTO. It requires about 30 percent less power than the Mulch-Master. However, there is less mulch reduction with the Big Bale Buster. Small bales do not work well with the Big Bale Buster and are not recommended for use with it.

Both machines can dispense wet moldy hay without plugging. Field production rates depend on the efficiency of handling and loading the mulch material. Strings or wires do not need to be cut or removed, increasing production. Either machine will spread large round bales of 1,000-to-1,500 pounds at the rate of one every 3 or 4 minutes.

Rangeland Imprinting In Utah

Thane J. Johnson, USDI-Bureau of Land Management, Utah State Office, Salt Lake City, Utah

Many of the Great Basin rangelands in Utah are characterized by a variety of soils varying in depth, texture, and salinity, but usually limited in production by low precipitation. The moisture-collecting capability resulting from imprinting appears to be very feasible for revegetating these rangelands following fire or other land disturbance such as pipeline construction.

This article describes a comparison study of the revegetation effectiveness of a locally constructed land imprinter and a conventional rangeland drill. An unseeded comparison was also included.

Arid Land Seeding

Harold T. Wiedemann, Agricultural Experiment Station, Texas A & M University, Vernon, Texas

A rubber-tired loader-grubber (920 Caterpillar) with foam-filled tires, currently under study by the Texas Agricultural Experiment Station, Vernon, Texas, appears to hold excellent promise for a practical method to control sparse stands of small trees such as mesquite on rangeland that has become reinvaded after rootplowing. Test data indicate the wheeled loader-grubber can average 9.7 acres per hour in an infestation of 22 trees per acre + seven.

The testing indicates a rubber-tired loader-grubber has the potential to maintain over 7,000 acres a year of rough rangeland.

Establishing Range Seedings By Irrigation

Brice E. Boesch, Bishop Associates, Denver, Colorado

(formerly with the USDA-Soil Conservation Service, Denver)

It has been suggested that supplemental moisture could be applied during the first growing season to enhance the emergence and survival of seeded grasses in areas of low annual rainfall. From a technical standpoint, irrigation may overcome, or help overcome, the problem of having to reseed rangeland two or more times to get a satisfactory stand of grass. However, it is not cost-effective, as it is estimated that irrigating rangeland one time to help establish a grass stand would cost $80-to-$140 per acre.

Revegetation Of Pipeline-Disturbed Land

Harry Somme, Tye Company, Lockney, Texas

After laying a pipeline, the disturbed area along the right-of-way must be reseeded with the specific species and population determined by extensive environmental impact studies. Special equipment is often needed for the seeding because of the terrain and the difficulty in metering the many different species of native grasses. Where terrain permits, drilling is the preferred method. A drill manufactured by the Tye Company has three seedboxes that can seed three kinds of seeds (medium heavy, small dense and light fluffy) and also dispense fertilizer all in one pass when equipped with fertilizer attachment. To seed the Alaskan pipeline, the unit was also equipped with opening coulters that insure a seedbed in areas of poor seedbed preparation.

Procedures for revegetation of land disturbed by strip mining differ from those of pipeline revegetation in that topsoil is usually added and prepared into a loose seedbed. Drill seeding of these areas is preferred where terrain permits, but requires a machine to meter many different types of seeds at a shallow depth. A machine manufactured by the Tye Company is designed for shallow planting of three different seeds (medium, small dense, light fluffy) while also dispensing fertilizer at the time time.

Land Imprinting Activities

Robert M. Dixon, USDA-Agricultural Research Service, Tucson, Arizona

Reduced to its fundamentals, land imprinting research has shown that:

1. Rainwater infiltration can be controlled by manipulating surface macro-porosity and micro-roughness;

2. These two properties interact to funnel rainwater into the soil and to funnel displaced air out of the soil;

3. The collapse of these naturally occurring fluid exchange funnels is both cause and effect of man-induced land degradation or desertification;

4. To reverse desertification, these funnels have to be rebuilt;

5. Land imprinting is a cost-effective mechanical method for artificially rebuilding these funnels;

6. Imprinter-formed funnels not only provide a good surface configuration for infiltrating water, but also provide excellent seedbeds and seedling cradles for revegetating barren desertified land; and

7. Vegetation established in the imprints then maintains the fluid exchange funnels through natural processes in the absence of overgrazing and overcropping.

A box-type land imprinter is being developed that is more versatile in design than the conventional cylindrical types. Several hand-operated imprinters were designed.

With the successful adaptation of a commercial broadcast seeder, the rangeland imprinter has been elevated to an Imprinting Revegetation System (IRS). Standards for testing procedures in southern Arizona have been established. Research plans are being developed for comparative analyses of IRS and the rangeland drill. Treatment effects to be contrasted will include the categories: mechanical, microhydrological, microclimatological and biological.

Seed Coating "Hard to Drill" Seeds

Wendall R. Oaks, USDA-Soil Conservation Service, Los Lunas Plant Materials Center, Los Lunas, New Mexico

Economics is only one factor that might support recommending seed coating. Other advantages include: more accurate seed placement, better seed mixing, use of conventional equipment, inclusion of nutrients, fungicides or herbicides in the coatings, and reduced seeding rates.

The objective of the project activities at the USDA Soil Conservation Service Los Lunas Plant Materials Center (PMC) is to reevaluate the feasibility of coating trash seed. To date, only preliminary work has been done. However, this work has shown it is possible to coat the most trashy seed, but coating costs are higher for such seed. More extensive studies will be carried out in 1982.

Transplanting Attachment For Front-End Loader For Use In Mine Reclamation

Kenneth E. Carlson, Colorado State University, Fort Collins, Colorado and James L. Smith, University of Wyoming, Laramie, Wyoming and Kent A. Crofts, Colorado Yampa Coal, Steamboat Springs, Colorado and Earl Frizzell, Bureau of Mines, Spokane, Washington

Transplanting mature, native vegetation is a new and much needed development in mined land reclamation. However, design and utilization of equipment to transplant mature vegetation has not kept pace with the development of equipment capable of creating disturbed mined lands. This paper describes a research program on the design and use of a front-end loader attachment that removes, transports, and places mature, native vegetation on graded mine spoil. The attachment was designed for a Terex 72071A front-end loader, but can be adapted to most large front-end loaders used in surface mining operations. The data indicates a substantial increase in aspen survival with the transplanting attachment. The results of this study suggest that transplanting of mature native trees and shrubs is a viable and cost-effective addition to accepted reclamation practice.

Disturbed Land Reclamation

Willis Vogel, USDA-Forest Service, Berea, Kentucky

A few years ago, the project engineer at the Forest Service reclamation research project in Berea, Kentucky, experimented with wood chips as an alternative method for controlling dust on a coal haul road in eastern Kentucky. The results strongly suggest that wood chips could significantly reduce the day-to-day use of water sprinkler trucks for controlling dust. The long-term effectiveness of the wood chips was not determined. There was, however, noticeable deterioration in the chips themselves and in the continuity of the chip blanket after 6 hours of traffic-imposed stress. Over an extended period the day-to-day advantage of the chips is unlikely to be as great as the ten-fold advantage noted during the period of the experiment.

Seed Harvesting

Stephen B. Monsen, USDA–Forest Service, Boise, Idaho

Two backpack seed collectors have been designed, built, and tested. A backpack seed harvester should not be built incorporating the desirable features from each unit. Workgroup efforts have centered on locating commercially available equipment that may have some potential for collecting wildland seed. The Echo PB-400 power blower shows some promise. This unit performs as either a blower or vacuum by moving an internal baffle. Seed can be vacuumed into a bag without going through the fan. Sufficient air velocity (6,500 up to 7,000 feet per minute) is produced in the 1.5-inch inlet to pick up and harvest many types of seed. A representative of Echo showed the PB-400 with the PBAV-400 (vacuum attachment) at the VREW meeting. The Echo PB-400 with vacuum attachment incorporates many desirable features of a backpack seed collector–lightweight (22.5 pounds), sufficient inlet velocity, no seed damage (seed does not pass through fan), fair amount of seed storage, and easy to operate. Two of these machines have been purchased for evaluation as backpack seed collectors.

Woodward Flail-Vac Seed Stripper

C. L. Dewald, USDA-Agricultural Research Service, Woodward, Oklahoma and V. A. Beisel, Aarons Engineering, Fargo, Oklahoma

A mechanical seed stripper has been invented and tested in Woodward County, Oklahoma, that proved to be an effective seed harvester for chaffy seeded grasses such as plains, caucasian, and ganada bluestem. The effectiveness of this new mechanical seed harvester results from a revolutionary design combining the following principles:

1. A flail-action stripper brush rotating upward on its exposed and leading edge;

2. A curved shroud positioned above the brush to create a high velocity, low-pressure airflow above and behind the rotating stripper brush resulting in a vacuum beneath the leading edge of the rotating stripper brush; and

3. A unique triangular shaped seed bin which retains the seed and turns the airflow 180 degrees where it escapes above the shroud.

Air-flow pulls the seed heads into the rotating brush where seeds are removed by the flailing action of the brush. Seeds are lifted into the airstream as they are removed and propelled into the seed bin. This new seed harvester is simple, effective and versatile. Ten 7-foot machines are being built on order and they will cover 2 to 3 acres per hour, collecting 200 pounds of seed per acre. Cost of these 7-foot units is $4,700 each.

Mechanical Plant Control Equipment

Stan Brown, Roscoe-Brown Equipment Corporation, Lenox, Iowa

The Roscoe-Brown Equipment Corporation has developed a versatile, all-terrain rubber-tired tractor capable of operating a variety of brush control and rehabilitation equipment. Some of the features of the Bear Cub tractor include: hydrostatic implement (chipper) drive; ROPS and FOPS canopy with cab enclosure option with-or-without pressurization and heater; front only, crab or coordinated 4-wheel steering and turbocharged engine for operation at high altitudes. The machine is powered and geared so that it can climb a 52 percent slope continuously and a 78 percent slope intermittently in any direction (contour, downhill, uphill).

Various interchangeable front and rear mounted attachments include: chipper, trencher, auger, back filler, backhoe, brush cutter, brush rake, brush shredder, dozer blade, snow blower, drop hammer and forklift.

The Eager Beever front-mounted chipped will chip material up to 1 foot in diameter and is not limited by material length. Production rates range from 50 to 75 tons per day, depending on material, terrain and the rate at which the chipper can be loaded. A knuckle-boom loader for the tractor chipper combination is available that allows the operator of the tractor to handle bigger and heavier loads than a man could possibly lift. The chipper can be mounted or unmounted from the tractor in about 15 minutes or less, and features curbside feeding and automatic feed wheel system.

Federal Photovoltaic Utilization Program

Albert C. Lawson, Federal Photovoltaic Utilization Program, Jet Propulsion Laboratory, Pasadena, California

The Federal Photovoltaic Utilization Program (FPUP) is part of the continuing federal support to the development of solar energy, specifically photovoltaics technology. The Department of Energy (DOE) anticipates FPUP to assist in accelerating the market development of photovoltaic technology and reduce the cost of photovoltaic applications.

Industry response to the program has been very good. There has been a steady increase in the number of companies that have developed capabilities and are seeking to provide photovoltaic systems.

Benefits of FPUP are:

1. Federal agencies are gaining experience in RFP's (Requests for Proposals), in evaluating proposals, contracting and operating photovoltaic systems;

2. System suppliers are learning how to design, install, operate, warranty photovoltaic systems, and learn how to respond to RFP's;

3. Federal agencies are procuring photovoltaic systems with their own funding;

4. Battery suppliers are placing increasing attention on development and application of batteries for the photovoltaic systems; and

5. A marked increase in the number of suppliers of photovoltaic systems has been observed.

Feasibility Of Direct Seeding Trees On Surface Mines In Kentucky

T. W. Richards, R. F. Wittwer and D. H. Graves, Department of Forestry, University of Kentucky, Lexington, Kentucky

Successful direct-seeding trials on mine soils have renewed interest in this reforestation method. Application of direct seeding to large-scale plantings requires the development of a planting machine capable of planting large seeds on variable topography and in rocky soils. Adaptation of an existing agricultural planter was investigated. Modifications met with reasonable success. Mine soils present no major problem for mechanical planting. Seed size limitations can be extended to plant most large-seeded species.

Modifications to plant variable slopes are the most difficult. Redesign and further development are needed to supply the mining industry with a dependable planting machine suited to the variable site characteristics encountered on mined land.

Solar Waterpumping Systems

Ronald W. Matlin, TriSolar Corporation, Bedford, Massachusetts

Over the past several years, a number of photovoltaic powered water pumping systems have been installed around the world. Several systems are described.

The design of a photovoltaic waterpumping system and the selection of components depend on many factors. The selection of the pump and motor greatly affects the system design. Centrifugal pumps have reasonable efficiencies down to the 20 to 25 gallons per minute pumping range. Below this their efficiency drops off rapidly. Volumetric pumps maintain good efficiencies at low pumping rates, especially at high heads, and therefore allow photovoltaic waterpumping systems to be cost-effective over a wider range than centrifugal pumps would allow. The two types of pumps have different load characteristics and hence present different problems.

In waterpumping systems of less than 10 kW (kilowatts), direct current (DC) motors are more efficient and cost effective than alternating current (AC) motors. Experience has shown that when energy storage is required, it is more cost-effective to store water in tanks than it is to store chemical energy in batteries. It is also desirable to use high voltage systems because efficiency of control electronics is considerably lower when low voltage systems are used.

Forest Service Equipment Development Center Activities

Ken Dykeman, USDA-Forest Service, Equipment Development Center, San Dimas, California

Some projects of interest to workshop participants are discussed: a mountain climbing backhoe with a unique design that allows individual control of each leg and wheel, with additional attachments available to increase versatility; an on-site chipper/conveyor for fire hazard reduction and residues reduction; a tractor with special suspension, gearing, and brakes that performs all the functions of an ordinary farm tractor, yet travels 50 mph on the highway; use of magnesium chloride for dust control; and a mobile hammermill that can efficiently reduce in-place oversize rock into a useful wearing course for an existing road.

Improvements To The Modified Hodder Gouger

Randall Chappel, R. W. Chappel Planning and Management, Calgary, Alberta, Canada and Bernie Jensen, Western Reclamation, Bozeman, Montana

Over the past year the Alaska Project Division of NOVA, an Alberta corporation, has been redesigning and building a modified Hodder gouger for its reclamation program on a major international pipeline. To make the modified Hodder gouger, designed and built by the Forest Service Missoula Equipment and Development Center, more suitable for high-production use, an independent ground wheel was designed. The wheel would drive the seedboxes and regulate a redesigned depression excavation control system.

Over-all machine operation control is achieved with a second small-diameter short-stroke hydraulic cylinder connected to a trailing-wheel elevating arm to lift the wheel off the ground. Blade arms and blades were redesigned to achieve greater clearance and a more effective basin shape for seed-holding, and the hitch was replaced with one from the rangeland drill.

The new machine was field tested in Alberta in the summer of 1981. NOVA's conclusion is that the control system is functional and allows complete adjustment of basin size and shape. It achieves the goal of producing consistent, predictable basins that are not directly affected by tractor hydraulics. There were problems, however, related to machine design that became apparent because of the actual machine use and the priorities of the user.

Electric Fencing – A State-of-the-Art Review

Ronald Jepson and R. Garth Taylor, Colorado State University, Fort Collins, Colorado

Electric fences have historically been used as temporary fencing. With recent innovations, electric fencing has been used as permanent fencing and as a method of upgrading existing fences. The chief advantages of electric fencing are low cost and ease of erection and removal. Like most fences, electric fences employ line posts and wire strands. However, they do not necessarily require corner braces. Disadvantages are that the fence must be kept in operation full time to be completely effective, livestock must be trained when first exposed, and frequent inspection and maintenance are required. A discussion reviewing the materials used in constructing an electric fence follows.

Grass Establishment–New Directions

Victor L. Hauser, USDA-Agricultural Research Center, Grassland, Soil and Water Laboratory, Temple, Texas

Current seeding and establishment methods frequently fail to produce adequate stands of grass. Three new grass establishment systems are discussed and available research data on their performance are evaluated.

Punch-planting is a method that places the seed in the bottom of an open, small-diameter hole deep in the soil where soil moisture is available longer than with conventional planting. Punch-planting established more plants than conventional planting in both greenhouse and field studies. However, two problems limit the use of punch-planting: rainfall fills the holes with soil, and available punch-planting machines are too slow and too weak for commercial use.

Live grass plants set into the field usually produce vigorous fast-growing plants. A new method for automating all phases of transplanting for grass employs the plastic bandoleer to permit mechanization of all phases of growing and transplanting grass plants. Transplants perform well in the field, but machinery to accomplish all phases of work is incomplete.

Grass seeds that were germinated before planting dramatically improved grass establishment both in the greenhouse and in field trials. Practical field use of germinated grass seeds should be easier to achieve than the other two methods because equipment is available now to plant germinated vegetable seeds.

This research demonstrates that substantial improvement in grass establishment technology is possible.

Savory Grazing Method

Noel Marsh, USDI-Bureau of Indian Affairs, Albuquerque, New Mexico

The Savory Grazing Method (SGM) derives its name from its originator, Allan Savory. SGM is a flexible grazing method that maximizes stock density for a minimum time and best can be defined as: "A method of managing the range and livestock through the optimization of four ecological phenomena by manipulating four range influences through a series of grazing management principles."

SGM has proved effective in improving rangelands in three continents over the past 17 years ranging from 2 to 100 inches of annual precipitation. The full understanding of SGM cannot be grasped without attending one of the courses that Allan Savory conducts. Savory is also completing a textbook on SGM titled, "The Savory Grazing Method of Holistic Grazing Management."

1983 Vegetative Rehabilitation and Equipment Workshop 37th Annual Report

Albuquerque, New Mexico

Introductory Address: The Sahelian/ Sudanian Zones Of Africa: Profile Of A Fragile Environment

Dr. Gerald W. Thomas, First Vice President, Society for Range Management, President, New Mexico State University, Las Cruces, New Mexico

This report focuses on a study for the Rockefeller Foundation of the food production potential of the marginal lands and semiarid regions of Africa, from Senegal to Somalia, south of the Sahara Desert. The study was approached with an ecological perspective–emphasizing the resource base for livestock grazing and rainfed crop production. Periodic drought, such as the major one during the period 1968 to 1974 that caused political upheaval and widespread starvation of livestock and people, must be considered as a basic component of the environmental complex. This major drought focused the world's attention on this fragile environment. Since this drought, substantial amounts of food aid and development assistance have been sent to the area. The dual challenge for the area is to increase food production for a population that will double in about 25 years and, at the same time, reverse the process of desert encroachment and resource development.

Overall food production is now keeping pace with population growth. To increase food production and slow down or reverse the desertification process the following eight categories are considered essential to a "holistic approach" to progress:

1. Responsible government programs and policies;
2. Proper use of resources–land, water, vegetation, energy;
3. Education and research as an investment in progress;
4. Focus on the farmer and pastoralist to create the incentive to produce;
5. Application of science and appropriate technology;
6. Balanced family nutrition;
7. Effective development assistance; and
8. A consideration of the ecological balance.

Adaptations of this formula must be made to fit individual country situations.

Vertical-Axis Tiller

Bill McGinnies, USDA–Agricultural Research Service, Crops Research Laboratory, Fort Collins, Colorado

Field tests of the vertical-axis tiller continued in 1982. The model tested was the Lely RH200-20, which has a working width of 80 inches and is designed for tractors of 40 to 75 PTO horsepower

On a saltgrass meadow in northcentral Colorado, the tiller was effective if the sod was first loosened with a chisel plow. In mulching studies in northcentral and northwest Colorado, the tiller could effectively incorporate 1,000 pounds per acre of either straw or grass-mulch with one pass over the area. The seedbed produced by the tiller is not as loose as that prepared by conventional rotary tillers.

The tiller produced a satisfactory seedbed when the soil was too wet to be worked with the usual plow and disk procedures. On hard, dry soils tilling is much more efficient if the soils are first loosened with a ripper or chisel.

The only operation problem encountered with the Lely tiller is the sharp angle of the PTO U-joints that result from the input shaft of the tiller being much higher than the tractor's PTO shaft. In 1982 a "Lelymatic Shearpin Automat" automatic shearpin replacer was installed on the tiller. The replacer was reliable in all aspects; shearpins consistently broke when heavy obstructions were encountered, but no shearpins broke unless there was an obstruction.

Mulch Spreading Equipment For Steep Slope Revegetation And Mine Reclamation

Carol S. Taylor, Colorado State University, Fort Collins, Colorado

The presentation is a summary of a state-of-the-art review report on mulch spreading equipment for steep slope revegetation and mine reclamation that is being completed by Colorado State University and the Forest Service Equipment Development Center, San Dimas, California.

To better evaluate the different types of mulch spreaders, they were divided into several categories. Criteria were developed from equipment user input, literature review and researchers' recommendations. For each category, the criteria were used to evaluate the equipment and rank equipment based on satisfying the criteria.

Equipment used for spreading and incorporating mulch were placed in the following four categories: mulch spreaders, power mulchers, hydraulic mulcher-seeders, and mechanical mulch incorporators.

Triangular Disk-Chain For Rangeland Seedbed Preparation

Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, Texas

A new triangular disk-chain, requiring only one tractor for pulling, developed by the Texas Agricultural Experiment Station, has reduced pulling requirements by 30 percent and increased operating width by 22 percent, compared to the standard two-tractor, diagonal pulling techniques.

Land Imprinting Activities

Robert M. Dixon, USDA-Agricultural Research Service, Tucson, Arizona

Land imprinting and desertification control research were accelerated in 1982 because of increased support. A new device called the brush-barrel seeder was developed and successfully used with the land imprinter to impose treatments on lands recently retired from irrigated cotton production.

New experimental sites were selected to represent various stages of desertification resulting from prolonged overgrazing and overcropping. Revegetation treatments included:

1. Ripping, seeding, and imprinting;
2. Seeding and imprinting;
3. Hand-seeding;
4. Drill-seeding; and
5. Untreated.

Treatments were laid out with long continuous borders to facilitate paired comparison analyses.

Stand density and forage production under the imprinting treatment were superior to the drill treatment. Compared with drill furrows, imprints were observed to stay wet several days longer after winter rains.

Other activities included the testing of different sized teeth under both simulated and natural rainfall in an effort to improve seedbeds and seedling cradles. Preliminary results were consistent with expectation.

Modification Of Chaffy Seeded Grasses With Air

C. L. Dewald, USDA-Agricultural Research Service Woodward, Oklahoma and V. A. Beisel, Aarons Engineering, Fargo, Oklahoma

Aerodynamic methods to modify chaffy grass seed by removing awns, hairs, fuzz, and chaff shows promise in early trials. The air compressor-driven power unit uses a venturi-shaped nozzle to propel air through a mixing chamber and into a venturi-shaped discharge muzzle. As the pressure decreases, due to increased velocity in the venturi constriction, the resulting vacuum formed in the mixing chamber pulls air, entrained seed into the power unit. Seed is expelled from the venturi mizzle. The air and chaff exits through the opening opposite the classifier air nozzle and momentum of the heavier seed propels them forward against a slight vacuum through the second opening in the "y" to achieve separation.

Seed Coating "Hard To Drill" Seeds

Wendall R. Oaks, USDA-Soil Conservation Service, Los Lunas, New Mexico

The objective of the project activities at the USDA Soil Conservation Service Los Lunas Plant Materials Center ·PMC) is to reevaluate the feasibility of coating trashy seed. Preliminary work continues on this project with additional seeds being coated and field studies planned for 1983. Initial tests show no detrimental effects from coating.

Plant Materials Progress In Texas

Richard B. Heizer, USDA-Soil Conservation Service, Temple, Texas

Since 1978 eight new plant materials have been released and two are in review from Texas by the Knox City Plant Materials Center, Knox City, Tex. in cooperation with the Texas Agricultural Experiment Station and various other state and federal agencies.

Included are: Alamo switchgrass (panicum virgatum), Shoreline common reedgrass (phragmites communis), T-587 old world bluestem (Dichanthium spp.), Yellow Puff littleleaf leadtree (Leucaena retusa), Aztec maximilian sunflower (Helianthus maximilliani), Loneta indiangrass (Sorghastrum nutans), rainbow wild plum (Prunus spp.), Saltalk alkali sacaton (Sporobolus airoides).

Plant materials to be released spring 1983: Haskell sideoats grama (Bouteloua curtipendula) and Sabine Illinois bundleglower (Desmanthus illinoensis).

Also the Texas SCS cooperated in four additional releases principally by ARS and/or Texas AES during this same period. These releases are: Nueces buffelgrass (Cenchrus ciliaris), Verde kleingrass (Panicum coloratum), Llano buffelgrass (Cenchrus ciliaris) and Brazos bermudagrass (Cynodon dactylon).

Colorado Environmental Plant Center

Sam Stranathan, USDA-Soil Conservation Service, Meeker, Colorado

The Upper Colorado Environmental Plant Center's first plant release is a cooperative one. The newly released Rincon saltbush is a product of collection and selection efforts by the Forest Service Shrub Science Lab (Provo, Utah) and field trials and orchard efforts by Utah Division of Wildlife Resources, Soil Conservation Service, and Meeker Plant Center.

The Meeker Plant Center provides foundation and registered seed to growers for nine other popular plant materials. New products in advance testing are: Utah sweetvetch, Louisiana sagewort, Slender wheatgrass, Antelope bitterbush and Serviceberry.

Old World Bluestem Release

Dr. William A. Berg and C. L. Dewald, USDA-Agricultural Research Service, Woodward, Oklahoma

Old World bluestems (Bothriocloa supp.) from southwest Asia have high forage and beef production potential when seeded and managed as monocultures on the Southern Plains. These introduced bluestems also offer potential for warm season pastures on the hilly lands of the southeast where tall fescue pastures are used during the cooler season. WW Spar bluestem (Bothriocloa ischaemum), a new release from the Southern Plains Research Station has high forage production potential under less than optimum soil moisture conditions and is more palatable than many other old world bluestem selections. WW Spar has shown excellent persistence and spring vigor in test plots in Oklahoma, northern Texas, central Kansas, and southern Illinois. WW Spar, like Caucasian bluestem, is susceptible to iron deficiency when grown on soils that are calcareous to the surface. Seed of WW Spar bluestem is available through the Oklahoma Foundation Seed Stocks, Inc.

Seed Harvesting

Stephen B. Monsen, USDA-Forest Service, Boise, Idaho

To date, the Seed Harvesting Workgroup has developed and field tested various backpack harvesters. All have usefulness in collecting seed of various species. No machine is universally adapted to harvest seeds of all plants. However, the "Elephant-Vac," a large commercial vacuum, has performed satisfactorily. The unit has sufficient suction to remove and draw large seeds of fourwing saltbush and other related seeds into the collection unit.

This collector must be transported on a pickup truck, which somewhat limits its usefulness on steep or inaccessible sites. The machine does not damage collected seeds because the seed does not pass through the blower. The machine is easy to operate. The unit has potential in harvesting seeds from shrubs grown under cultivation. It is particularly useful in collecting light-weight seeds. It has also proved useful in harvesting seed from shrubs such as shadscale saltbush and spiney hopsage.

Woodward Flail-Vac Seed Stripper–Update

C. L. Dewald, Agricultural Research Service, Woodward, Oklahoma and V. A. Beisel, Aarons Engineering, Fargo, Oklahoma

During 1982, the first year of commercial use, 29 Woodward Flail-Vac seed strippers were manufactured and sold. These strippers harvested more than 60,000 pounds of pure live seed of Caucasian, WW Spar, plains, and ganada bluestem during the first season of use. Most of the harvesters manufactured were 7 to 10 feet in width for mounting on a front-end loader. Two 14-foot wide strippers were adapted for and mounted on cotton stripper chassis.

The success achieved by the Woodward Flail-Vac seed stripper is a result of its simplicity, effectiveness, and versatility.

Western Reclamation Group Progress Report–1982

Wayne E. Sowards, Trapper Mining, Incorporated, Craig, Colorado

The Western Reclamation Group was formed in 1981 by representatives of the coal mining industry, environmental consultants, state regulatory agencies, and universities. The group formed in response to existing and incipient regulations, guidelines, and policies for the standards of revegetation for coal mined lands.

The group has evaluated the regulations, policies, and guidelines for revegetation success standards of six western states and the Denver Office of Surface Mining. The evaluations were made by four working subgroups to consider four major topics:

1. Land use determinations and classification;
2. Management of reclaimed lands;
3. Quantitative evaluations procedures; and
4. Concepts of reclamation standards.

The subgroups presented their preliminary findings at WRG workshop held in Denver in April 1982. The comments elicited from the workshop were used to finalize the findings and conclusions of the group. These materials are directed to all persons involved in planning, studying or administering standards of revegetation success for mined lands.

Land Imprinter Results In Utah

Warren P. Clary, USDA-Forest Service, Provo, Utah and Thane J. Johnson, USDI-Bureau of Land Management (retired), Salt Lake City, Utah

At the 1982 VREW, Thane Johnson described a study to be conducted by the Intermountain Forest and Range Experiment Station and the Utah State Office of the Bureau of Land Management. This study was a comparison of the revegetation effectiveness of a locally constructed land imprinter and a conventional rangeland drill. An unseeded comparison was also included in the test.

Initial results from the Little Oak Creek burn in central Utah suggest significantly better establishment of seeded forage species planted by the land imprinter as compared to the more conventional rangeland drill under our conditions of severe wind conventional rangeland drill under our conditions of severe wind erosion. Further measurements and observations will be made before final conclusions are reached regarding relative seeding success and native plant response.

Land Treatment By Chaining On The Dixie National Forest

Frank R. Jensen, USDA-Forest Service, Dixie National Forest, Cedar City, Utah

Much of the 145,000 acres seeded on the Dixie National Forest were prepared for seeding with modified anchor chains, aerially seeded, then chained a second time to cover the seed.

A number of different chain lengths, chaining patterns, types of digger teeth, swivels, and clevises have been tried in the Dixie National Forest. From these experiences, the following is recommended:

1. Total chain length of approximately 250 feet and weighing about 15,000 pounds;

2. Pull the chain in a "U" pattern with tractors no more than 75 feet apart. Tractors can be moved to 50 feet for a more complete job, but the narrower the swath, the greater the degree of vegetation uprooting and seedbed scarification; and

3. Approximately 175 chain links should have digger teeth. There should be approximately 45 feet of smooth chain on each. The swivel should be placed at the connection between the smooth chain and the digger teeth equipped chain.

Ground Sprayers For Sagebrush Rangelands

James A. Young, USDA-Agricultural Research Service, Reno, Nevada

Using herbicides to control brush and weeds, release forage species, or seed desirable forage species is a valuable range improvement technique. Herbicides usually are applied aerially on rangelands because of their extensive and often rugged terrain. For small acreages in remote locations it is often impossible to obtain aerial applicators. This report describes modifications of power-ground sprayers to permit their use on rangelands. The modifications to booms, boom supports, and suspension can be done in typical farm shops. Techniques for calibration and tips for operating rangeland sprayers are also given.

Structural Range Improvements

Billy H. Hardman, USDA-Forest Service, Region I, Missoula, Montana

This year the structural range improvements workgroup has field tested a new type of posthole digger called a Can-Do Digger. With this new posthole digger a posthole can be dug 42 inches deep with only a 6 inch diameter from the top down. This is made possible by the double crossover design of the handles. The cost is about $75. The digger is manufactured and marketed by Can-Do Diggers, Inc.

Boom For Pneumatic Fencepost Driver

James A. Young and Richard Madril and Victor Rashelof, USDA-Agricultural Research Service, Reno, Nevada

The pneumatic post driver is a useful tool for driving steel fence posts; however, the 65-pound weight of the driver makes it very tiresome and difficult for a single operator to handle. To make the driver more convenient for one operator, a counterbalanced boom was designed to suspend the driver at the correct height for driving posts.

The relatively inexpensive counterbalance boom greatly enhances the usefulness of the pneumatic post driver. Use of the modified boom makes the driver a one-person tool. Design and specifications given.

High Performance, Counterbalanced Wind Machine Development

Floyd C. Sutz, Executive Vice President, Sind Baron Corporation, Phoenix, Arizona

A high performance waterpumping wind machine that begins operation in winds of only 3 to 5 miles per hour is now available from Wind Baron Corporation. The 21-foot diameter Mark IV Wind Machine incorporates a patented counterbalancing system that eliminates 100 percent of the sucker rod weight and 50 percent of the water column weight and allows operation in light winds. Additionally it has sensitive wind "tracking" features that further enhance its performance.

In a 7 month, side-by-side test certified by Texas A&M University, a Wind Baron wind machine delivered over 13 times more water than a conventional windmill in winds below 10 mph, and over 32 percent more in winds above 10 mph.

Wind Baron has also developed several well simulators to assist in performance testing. With the use of these well simulators, any reasonable well depth can be simulated, which allows windmill performance testing at various simulated water depths without the need for a well. The company will readily make this technology available to other wind system manufacturers and outside parties interested in its use.

Accomplishments Of The VREW–History

Richard Hallman, Range Program Leader, USDA-Forest Service, Equipment and Development Center, Missoula, Montana

The Vegetative Rehabilitation and Equipment Workshop, VREW, is a forum to provide exchange of ideas to enhance the development and dissemination of technology used in improving rangelands and surface mined soils. The work of VREW can be broadly divided into four categories:

1. plant control;
2. ground preparation;
3. seeding and planting; and
4. publications.

Major projects in each of these fields are reviewed.

"Anchor Chains, Projects 602 and 1790" evaluated combinations of cables and light chains, and then continued to work on improving the effectiveness of chains on brush control. Two distinct chains were developed, the Ely, by BLM in Ely Nevada, and the Dixie Sager by Dixie National Forest, Utah. Drawings of chains are available from Missoula Equipment Development Center (MEDC). A handbook on chaining, "The Ely Chain," was also prepared.

The objective of "Brushland Plow, Project 328" was to design a rugged plow patterned after the Australian "Stump Jump Plow," for use on rangelands. The results of this effort produced a most durable and effective plow for wildland situations. Drawings and a service parts manual are available from San Dimas Equipment Development Center (SDEDC).

The purpose of the "Browse Seeder, Project 502" was the development of an appropriate means of seeding browse, forbs and grasses for wildlife habitat improvement. A satisfactory seeder was developed in cooperation with the Walter Hanson Machine Company. Drawings are available from SDEDC.

VREW is increasing the effort to provide land managers with pertinent, up-to-date information. Much of this information is published in newsletters, Equip Tips, Project Records, VREW annual reports, service and parts manuals, operations handbooks, and the "Catalog–Revegetation Equipment." A growing emphasis is also being placed on collecting and distributing current information about equipment and techniques for rangeland improvement and disturbed land revegetation.

Accomplishments Of VREW–Development Of The Rangeland Drill

Dan W. McKenzie, Range Scientist and Mechanical Engineer, USDA-Forest Service, Equipment Development Center, San Dimas, California

The rangeland drill is VREW's most successful project. It has been used for over 30 years in the rangelands of the western United States and in several foreign countries. In recent years, the rangeland drill has also been used extensively for strip mine reclamation. It is an excellent example of cooperation between government and private enterprise.

The rangeland drill progressed through four phases:

1. Conceptual, carried out by the Range Seeding Equipment Committee;
2. Demonstration and validation, carried out by the Freemont National Forest;
3. Full-scale engineering development by the San Dimas Equipment Development Center (SDEDC); and
4. Production, use and product improvement phase which was carried out by several groups. Production was by private enterprise under contract, the use portion was carried out by the Forest Service, Bureau of Land Management, Bureau of Indian Affairs, Soil Conservation Service, various states and private firms. Project improvement has been carried out by SDEDC, the equipment fabrication contractors and the user.

BLM's Rangeland Rehabilitation Equipment Pool, Vale, Oregon

Cliff Hiatt, USDI-Bureau of Land Management, Vale, Oregon

The Bureau of Land Management's (BLM) Rangeland Rehabilitation Equipment Pool, operated by the Vale District of BLM, Vale, Ore., contains 70 rangeland drills and 19 brushland plows. These drills are available on loan to any BLM district on a first-come, first-served basis. After BLM needs are met, this equipment is available to other US Government agencies. The equipment can also be loaned to farmers and ranchers through agreements with the Soil Conservation Service.

Vale will provide a training seminar on range rehabilitation equipment to BLM Districts on request. These seminars are designed to familiarize range conservationists and supervisors with range rehabilitation equipment.

Ecological Considerations In Designing And Selecting Reclamation Equipment

Willis G. Vogel, USDA-Forest Service, Northeastern, Forest Experiment Station, Berea, Kentucky

It has been recommended that the Vegetative Rehabilitation and Equipment Workshop identify and promote a better understanding of the ecology of the land to be treated as a first step in designing and modifying equipment. The precept is also applicable to the selection of existing equipment. This paper describes where and how ecological principles may relate to and be considered in the design, modification, and selection of equipment for reclaiming and vegetating disturbed lands.

Ecology seemingly has been considered, either consciously or unconsciously, in designing and modifying many of the pieces of equipment used in reclaiming disturb lands. Failure to consider ecological factors seems to occur most often in the selection of equipment that is already available. Reasons for this are most often related to economics and convenience and familiarity to the user. Some of the revegetation problems related to equipment selection result directly or indirectly from the requirements of reclamation laws and regulations that were not based on ecological considerations. Some of these problems can be overcome with better selection and more judicious use of existing equipment.

The Savory Grazing Method

Allan Savory, SGM Range Consultants, Albuquerque, New Mexico

The Savory Grazing Method (SGM), or holistic resource management, is a way of managing all of the resources in any ecosystem to produce a desired goal. When you apply SGM, you will manipulate the various components that make up the range ecosystem to achieve a desired end result on the whole. Where conventional range management is based almost entirely on plant management, SGM is based on the management of the "whole," including precipitation, sunlight energy, soils, plants, animals of all forms, biological succession, financial and labor resources, seasonal and daily changes in growing conditions and a host of other factors. It cannot be applied as a system as it has to be tailored to each situation and each season, and yet it is universal in its application.

How Can VREW Tie With MARC?

Lauri Zell, Mining and Reclamation Council of America, Washington, DC

The Mining and Reclamation Council of America (MARC) and VREW share an important common goal: providing a forum for exchanging ideas to enhance the development and dissemination of technology used in improving coal mining and reclamation. MARC was established in 1977 as the national trade organization representing the surface coal mining community.

One of MARC's primary strategic objectives is to aid in the development of relevant research and transference of results of coal mining studies to the industry as expeditiously as possible. Recently, MARC endeavored to determine the research needs of the industry through a nationwide assessment. The results of the assessment provide a documented frame of reference for federal and private decision making regarding priority research needs.

Two policy recommendations were frequently addressed by participants nationwide. The first is the need for more efficient technology transfer; the second concerns the need for developing a regulatory environment that encourages the use of experimental practices during mining and reclamation activities.

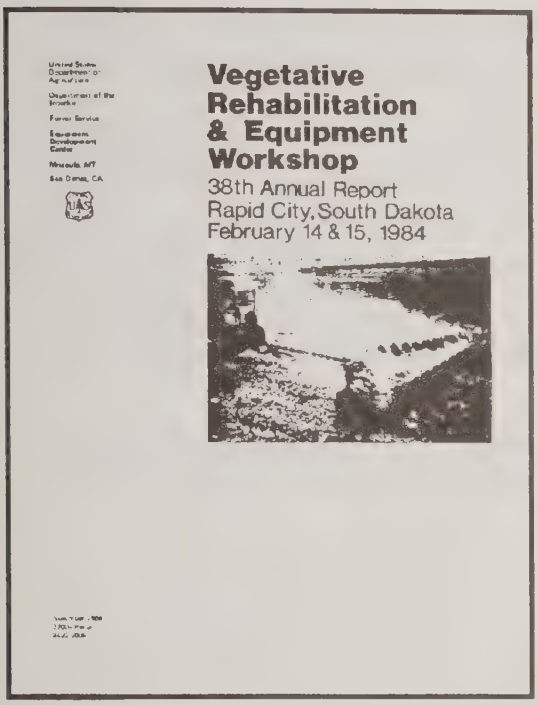
Specific production and reclamation technology suggestions focus on five major topics: hydrology, sediment control, reclamation, air quality and blasting.

Coordination Of Mined Land Reclamation On National Forest System Lands

Wayne Patton, Minerals and Geology Staff, USDA-Forest Service, Washington, DC

It is critical for minerals specialists to coordinate with those having expertise in reclamation. Mineral specialists have the job of coordinating reclamation efforts with the other disciplines. However, plant materials and soils specialists should contact minerals experts at least two-to-three years before expertise is needed. Topics to consider include on-going and future mineral projects and future reclamation needs as well as plans to supply the needed knowledge.

The time for plant materials and soils experts to become involved in the reclamation effort for a mineral project is at the first phase when baseline information is collected and plants are made (jointly with industry) regarding post-mining land use. Reclamation expertise is built into the plan of operation for the mineral project. The reclamation specialists carry out operational supervision and monitor operating plan compliance. The final involvement comes during reclamation field work at the end of a mineral project and management of the post-mining landscape for the selected end land use. The key to this whole process is early involvement in the reclamation planning process.



1984 Vegetative Rehabilitation and Equipment Workshop 38th Annual Report

Rapid City, South Dakota

The Changing Role Of VREW In Rangeland Management

Jack Bohning, Past President, Society for Range Management, Prescott, Arizona

VREW's objective was to provide an exchange of ideas to enhance the development and dissemination of technology used in improving rangelands and surface-mined soils. A maturing in the philosophy of range improvement work is strongly evident in the statement that to better identify an equipment project, VREW may promote an understanding of the ecology of the land to be treated as a first step in modifying or designing new equipment.

VREW achieves its objectives in a variety of ways. A prime factor in its success to date. VREW provides a catalyst for stimulating ideas and proposals from a wide array of sources and provides a vehicle for publication of information with an in-place distribution net.

In the future VREW members should consider the critical need for continuing VREW programs, the need to emphasize energy-efficiency in developing tools for range improvement and mine rehabilitation and the need to sell rangeland and mine rehabilitation work as necessary for both economic and social benefits.

A Partner In Equipment Development

Farnum M. Burbank, Mechanical Engineer, Equipment Development Group, Washington, DC

VREW has been a true partnership between resource managers and engineers in equipment development over the past 37 years.

The broad objectives of the VREW have been to keep abreast of the field of commercially developed equipment, to make modifications as required for adaptation to wildland use, and to develop equipment not commercially available.

With the rapidly growing interest in, and demand for, rehabilitation of disturbed lands in the 1970's, the VREW program has become quite heavily oriented toward the stabilization of disturbed lands, although project work continues on range improvement equipment.

The results of VREW have been significant. Perhaps the cooperative spirit engendered by the Workshop is as important as any of its achievements. It is a classic example of what can be accomplished if no one is too concerned about who gets the credit!

Panel Discussion: Chemical, Thermal, And Mechanical Control Of Noxious Weeds–Progress And Prognosis

Russell J. Lorenz, USDA-Agricultural Research Service, Mandan, North Dakota

Leafy spurge (Euphorbia esula L., E. virgata Waldst. & Kit, and closely related Euphorbia species) is an introduced weed that has become a major problem in the United States and Canada, particularly on rangelands in the northern Great Plains. Consequently the panel speakers address the topic of noxious weed control primarily in terms of leafy spurge. The same general principles apply to other perennial weedy forb problems given some fine tuning for the specific problem.

No single research or extension group has received enough funding to carry on an independent program that would in itself be effective. However, by redirecting efforts between federal, state and provincial units, sizeable gains have been made in control technology.

Leafy Spurge On The Northern High Plains–Characteristics, Site Requirements And Concerns

Ardell J. Bjugstazd, USDA-Forest Service, Rapid City, South Dakota

Physical description and characteristics of the leafy spurge (Euphorbia esula L.) plant are given, including leaves, roots and seeds.

Birds are considered the primary disseminators of spurge seed. Lowland range sites and bottomland topographical positions on the northern High Plains have been described as sites where leafy spurge dominates over other herbaceous vegetation in the community. Efforts to control the noxious weed on this site will also affect hardwood species on these sites or prohibit regeneration of hardwood species. The data suggest that management closely monitor lowland and sandy range sites for infestations of leafy spurge and immediately investigate control efforts at initial infestation.

Evaluation Of Original And Repetitive Herbicide Treatments For Control Of Leafy Spurge

Harold P. Alley, University of Wyoming, Laramie, Wyoming

An extensive repetitive herbicide treatment program for leafy spurge (Euphorbia esula L.) was initiated in 1978, and the effect of original and retreatments on leafy spurge shoot and root control has been evaluated since the initiation of this study.

The most consistent and effective original-plus-repetitive treatment included picloram as a component of each of the treatments.

Biological Control Of Noxious Weeds–Progress And Prognosis

Lloyd A. Andres, USDA-Agricultural Research Service, Albany, California

The fact that most studies of biological control to date have focused on the collection, testing, and release of new natural enemies against introduced weeds makes people often think of biological control as the substitution of "bugs" for chemicals to solve weed problems. More appropriately, biological control should be considered as the use and management of natural enemies to stress weeds and that the natural enemies are only one part of the weed management program. The release of exotic insects or pathogens is but a first step in the management process. To achieve a balanced range system, each manager should be aware of the capabilities and shortcomings of the control organisms and how to enhance their impact on the weeds.

The biological control process has become increasingly complex. A number of steps are now required to clear exotic potential control of organisms in the United States. Concern over the fact that these organisms may attack and impact on native plants has complicated testing and decisionmaking processes immensely. On the positive side, there has been increased recognition of the role that biological control might play in the control of weeds in the United States and the need for this approach.

We must be aware of the far-reaching consequences that the release of an insect (or chemical molecule) into the environment might have on the target weed as well as other weeds. Some hard choices will have to be made. We must be aware of the motives behind our actions and that the economic balance sheet is only one factor to be considered.

Progress In Biocontrol Of Weeds Of Southwestern Rangelands

C. J. DeLoach, USDA-Agricultural Research Service, Temple, Texas

At Temple, Tex. we have selected weeds amenable to biological control based on three criteria:

1. The weed (or its close relatives) occurs as a native species somewhere else in the world where we can find natural enemies;

2. The weed (or its close relatives) does not have over-riding beneficial values to either man or the ecosystem; and

3. The weed causes sufficient losses to be worth the cost of research.

This selection revealed that most of the major problem weeds of the Southwest that might be controlled biologically are native plants. A summary of the following target weeds is presented: snakeweed (Guitierrezia sarthorae, G. microcephala), baccharis (B. neglecta, B. glutinosa, B. halimifolia), mesquite (Prosopis glandulosa and P. velutina), creosotebush (Larrea tridentata), tarbush (Flourensia cernua), Whitebrush (Aloysia gratissima), bitterweed (Hymenoxys odorata) and Pinque (H. richardsonii), loco weed (Astragalus spp.) and salt cedar (Tamarix spp.)

Biological control of introduced species appears to be technically feasible, economically sound and not harmful (and may even be advantageous) to the ecosystem. The biocontrol of certain native weeds also seems feasible, though it is more difficult and requires more careful consideration of the effects on the ecosystem than does the control of introduced weeds.

Biological Control Of Noxious Weeds In Montana

Norman E. Rees, USDA-Agricultural Research Service, Bozeman, Montana

Thirteen biocontrol agents have been released on seven major problem weed species in Montana with varying results. In addition, a fourteenth agent has recently immigrated from a Canadian release site and is becoming established throughout much of the state.

Discussed are: Chrysolina quadrigemina, Agrilis hyperici, Zeuxidiplosis giardi, Rhinocyllus conicus, Trichosirocalus horridus, Ceutorhynchus litura, Urophora cardui, Calophasia lunula, Urophora affinis, Sphenoptera jugoslavica, Urophora quadrifasciata, Metzneria paucipunctella, Hyles euphorbiae and Oberea erythrocephala.

Arid Lands

Earl F. Aldon, USDA-Forest Service, Albuquerque, New Mexico

The speaker presents some of the latest findings from research conducted in the Southwest and presents his ideas for needed future reclamation research.

Recent findings include:

1. Increased surface mining of coal in the Four Corners area of the United States has caused concern as to whether cast overburden (spoil), due to runoff, contributes significant sediment to the already high levels in area streams. After sixteen runoff events in 8 years, runoff plot data are well correlated and show runoff and sediment production from graded but otherwise untreated spoils are within tolerable limits;

2. Mining reclamation specialists and government regulators need sound criteria for judging when reclamation is complete and bonds can be released. Three common and easily measured parameters are cover, density, and diversity;

3. Western wheatgrass (Agropyron smithii) will survive and spread when broadcast seeded on raw mine spoil receiving some additional moisture as a result of topographic shaping;

4. After reclamation was complete, plantings on northwestern New Mexico raw mine spoils from 1973, examined for establishment (1975) and survival (1979) showed 75 percent survival of fourwing saltbush (Atriplex canescens (Pursh) Nutt) and Alkili sacaton (Sporobolus airoides (torr.) Torr.) cover was four percent;

5. A study by Cress (1982) found three native plant species–fourwing saltbush, galleta (Hilaria jamesii), and western wheatgrass–responded to varied watering regimens by producing greater amounts of proline as moisture stress increased. A comparison of the three species showed a trend toward greater survivability at lower soil moisture levels as the proline content increases; and

6. Studies suggest that selected organic amendments to mine spoils may achieve reclamation goals faster than the more expensive topsoil/mulch procedures currently used in reclamation procedures.

Seedbed Preparation–The Forgotten Step In Range Seeding

William J. McGinnies, USDA-Agricultural Research Service, Fort Collins, Colorado

Seed of most species used for range seeding is small, and seedling vigor is low. Planting seed of most species below 1 inch results in seedlings failing to reach the soil surface, and there is a great reduction in seedling emergence. Because of surface soil drying, much of the seed planted less than 0.5 inch deep will fail to germinate. Thus, careful control of seed depth is essential to range seedling success.

Seedbed firmness also has a great effect on soil moisture relations. Soil firmness affects capillary pore space, and the amount of moisture that a seedbed can hold is directly related to the amount of capillary pore space. The ideal seedbed will be sufficiently firmed so that there is adequate capillary pore space, and yet is not so compacted that the reduced pore space prevents water infiltration.

The methods used to prepare a seedbed depend on the previous treatments. The tillage operations used to produce a smooth firm seedbed are an additional expense to be added to the already high cost of range vegetation. In many cases, however, the better seedbed will permit lower seeding rates which in turn will reduce seeding costs. It is also anticipated that the failure rate will be lower and costs of replanting reduced.

Better seedbed preparation will also reduce the need to develop and purchase specialized range seeding equipment because a smooth, firm, seedbed can be readily planted with commercially available farm and pasture drills, and this can be a considerable savings.

Triangular Disk-Chain Activities

Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, Texas

The triangular disk-chain developed by the Texas Agricultural Experiment Station for low-cost seedbed preparation on log-littered rangeland has functioned well in field tests during 1983. In kleingrass establishment studies, there was no significant difference in plant densities between seedbeds prepared by the triangular and diagonally pulled chains. Plan densities were increased by smooth chaining following both disk-chaining techniques.

In draft requirement studies using 24- and 28-inch diameter disk blades, the triangular disk-chain reduced draft by 36 percent and increased operating width by 23 percent compared to the diagonally pulled chain. Differences were significant at the p=.001 level. The optimum size, 24-inch disk-blade and two-inch chain, required 150 pounds per blade draft in freshly disturbed soil. These and other data are covered in ASAE Paper No. 83-1609 available from the author.

Woodward Laboratory Air-Seed Shucker For Rapid Quality Determinations Of Chaffy Seeds

C.L. Dewald and V.A. Beisel, USDA Agricultural Research Service, Woodward, Oklahoma and Aarons Engineering, Fargo, Oklahoma, respectively

The Woodward Laboratory air-seed shucker gives rapid extraction of caryopses (grain) from chaffy seed for a quick and accurate determination of pure seed content. The air-seed shucker is powered with compressed air which enters the power unit nozzle and travels through the mixing chamber to exit through a venturi muzzle at supersonic speeds. Air-entrained chaffy seeds enter the mixing chamber and are subjected to an impelling air blast and acceleration force that strips subtending appendages from the grain. When the grain is shucked, its density (mass/volume) is increased and it drops from the shucker against a vacuum resistance in the classification cylinder. Seeds not shucked on the first pass through the power unit exit the venturi muzzle, travel with the air through a recycling tube and re-enter the system by means of a cyclone air separator until shucking is complete.

Determnation of pure seed content of chaffy seeds by standard methods is slow, tedious and subject to much human error due to a large volume per weight ratio and extraneous materials to contend with. Two-to-four hours are required for a single purity analysis by standard methods. Whereas comparable determinations can be done in less than two minutes with the aid of the air-shucker. More accurate as well as more meaningful results are obtained when the extracted grain method is used. In addition to the seed analysts, seed producers and processors will benefit by the rapid extraction method in timing of operations and monitoring pure seed content with the Woodward laboratory air-seed shucker.

"Native" Versus "Exotic" – The Dilemma Of Ecologically Sound Mine Waste Revegetation

Stuart A. Bengson , ASARCO, Incorporated, Shuarita, Airzona

ASARCO has had over 15 years experience in creating viable "naturalistic" ecosystems in the arid Southwest utilizing both "native" and "exotic" plant species. This experience has proven that species selection must be based on the specific site requirements and not limited to the few native species that may be endemic to the site. The mixture of native and exotic species creates a productive ecosystem that enhances the land resource values and harmonizes with the adjacent undisturbed "natural" areas.

Merritt Island Brush Burning

Richard Hallman, Range Project Leader, USDA Forest Service, Equipment Development Center, Missoula, Montana

A truck-mounted boom-burner was evaluated by personnel at the Merritt Island National Wildlife Refuge near Titusville, Florida. The refuge is unique in that fire control must accommodate thousands of acres of land that is intermingled with marshes, rivers and lakes, and approximately 260 miles of dikes. Refuge personnel found that the boom can easily cover the fuels on both sides of the dikes and that they could ignite fuels on one side of a dike while driving over four mph. The Fish and Wildlife Service will continue to evaluate this ignition equipment in an attempt to perfect a rapid system for managing the vegetation on the many miles of dikes on the Merritt Island Refuge.

Foam Marking Systems For Rangeland Sprayers

Maurice R. Gebhart, USDA Agricultural Research Service, Columbia, Missouri; Allen Torell, Utah State University, Logan, Utah; James A. Young and Raymond A. Evans, USDA Agricultural Research Service, Reno, Nevada

Numerous foam marking systems are commercially available and are in general use in intensive agriculture in the Midwest and Great Plains. When applying herbicides to rangelands with a ground sprayer, a marking system helps avoid skips and overlaps in spraying, especially in undulating terrain or tall brush.

Skips or overlaps in herbicide application resulting from loss of orientation by the sprayer operator are a concern because of poor brush control in the skipped areas and added costs of herbicides and spraying time when double coverage occurs. Soil-active herbicides used for controlling cheatgrass (Bromus tectorum) require that there be no overlaps in application since excessive residues in the soil can prevent forage seedling establishment and plat growth.

The foam marker system is an economical way to improve sagebrush kill while spraying. Just as importantly, the needed investment is relatively small.

Low-Cost Diagonal Fence Strainer

Dan W. McKenzie, Range Scientist and Mechanical Engineer, USDA Forest Service, Equipment Development Center, San Dimas, California, and W.F. (Bill) Currier, USDA Forest Service (Retired), Albuquerque, New Mexico

Corner, line, and gate or fence end braces (or strainers) are an important part of any fence. With the use of high tensile, smooth wire, these strainers are of even greater importance because of the necessity of maintaining the complete fence at the recommended tension. In recent years, the horizontal fence strainer (or the double horizontal fence strainer) has been accepted as the standard and strongest fence strainer design. However, another fence strainer design, known as a diagonal fence strainer, is structurally equal to the horizontal fence strainer, but is much less costly to install. It requires one less post and only about half the labor to install. A diagonal fence strainer is equal in strength and holding force to a horizontal strainer. It has the same lifting force on the cornier post as a horizontal strainer of the same size. On a high-tensile, smooth-wire fence, one diagonal strainer can be used for a corner in place of the currently used two horizontal braces.

Solar-Powered Pumping Systems

Mike Easterly, Grundfos Pumps Corporation, St. Louis, Missouri

Photovoltaics, the science of converting sunlight into electrical voltage, has been used for many years. Photovoltaics are taking an active role in groundwater pumping with complete solar-powered pumping systems now available. This new approach to pumping offers an innovative energy-saving alternative for many applications.

Solar-powered pumping systems are a viable alternative to conventional pumping systems. While the sizing, selection and installation of these systems are different from conventional systems, the pertinent data and complex calculations have already been compiled and are now available in an easy-to-use selection and installation manual.

Progress In Nonstructural Range Improvements In The Northern Great Plains–Future Needs

F.R. Gartner, South Dakota State University, West River Agricultural Research and Extension Center, Rapid City, South Dakota

Mechanical treatments of rangelands are popular in the northern Great Plains because they conserve water–a direct benefit to native plants. Non-structural, or mechanical, range improvement methods have been under study by federal and state researchers for several decades.

There is an apparent link between effective precipitation, soil characteristics, forage production and livestock performance. The latter is specifically a function of forage quality and quantity. In over 25 years of examining various range inputs, most of which were spent in the northern Great Plains, mechanical treatments appear to be the most consistent range improvement for assuring the stability of forage quantity and improvement of forage quality. Further, mechanically treated range provides the best "grass insurance" during dry cycles.

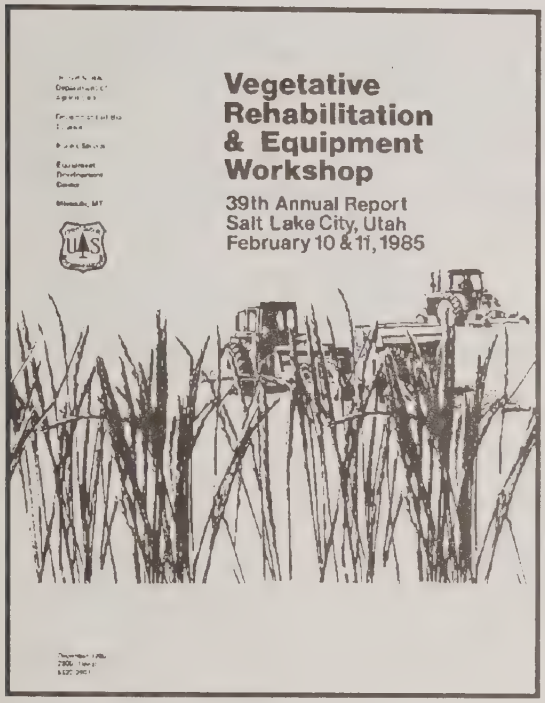
Range Improvement Machine

P.O. Currie and R.S. White, USDA Agricultural Research Service, Miles City, Montana, and L.R. Erickson Montana State University, Bozeman, Montana

A prototype rangeland improvement machine (RIM) was developed for interseeding rangeland or renovating problem marginal farmland. The unit tills the soil, forms a vee-trough seedbed and plants in a single-pass operation. Soil tillage is accomplished with a rototiller. A packing wheel assembly forms continuous, packed furrows on farmland. On rangeland, the furrows have intermittent check dams for water retention and control. Furrows are large enough to retain water and remain intact for a number of years but small enough to minimize field traffic problems. Various types and combinations of seed and fertilizer can be planted and applied with the modified all-purpose drill.

To date, field work has been an effective test of machine concept and machine components. The machine performs according to initial concept when soil moisture conditions are good. A number of rototines have been worn out, but breakage has generally not been a problem even in the rocky test site in western Montana. Mechanical components of the field generation prototype machine were rigorously tested in establishing the research treatments. Several structural components were damaged or failed during field tests and have been modified, strengthened, or replaced in the current RIM.

A prospectus has been developed for VREW for a third generation machine suitable for use by individual ranchers, agencies, or conservation districts. This machine would be less complex and of lower cost that the prototype research machines.



1985 Vegetative Rehabilitation and Equipment Workshop 39th Annual Report

Salt Lake City, Utah

Panel Discussion: Soil Conservation Service

H. Wayne Everett, USDA Soil Conservation Service, Fort Worth, Texas, and Wendall R. Oaks, USDA Soil Conservation Service, Los Lunas, New Mexico

The Soil Conservation Service (SCS) operates a coordinated network of 24 plant materials centers in the United States to assemble, evaluate, select, cooperatively release and provide for the commercial increase of native and introduced plants for the conservation and improvement of soil, water, and related resources.

Standardized procedures have been developed and are being used for this comparative plant testing program. Evaluation data can be retrieved from an automated data processing system through standardized or user-designed reports.

Over 150 SCS-released varieties of conservation plants are available commercially for range, pasture, and other land improvement to reduce sediment movement and improve wildlife habitat. These improved plants can also solve other erosion problems, including the reclamation of surface mined land, roadside development and sand dune and shoreline stabilization. A number of new varieties for use in grassland plantings are now available.

Acquisition, Storage, And Distribution Of Plant Germplasm

Louis N. Bass, USDA Agricultural Research Service, Fort Collins, Colorado

Plant germplasm in its broadest sense consists of all living species, subspecies, and their genetic variants. In recent years, interest in conservation of available plant germplasm for use in future plant breeding programs has increased steadily worldwide. Throughout the world, the major emphasis in germplasm conservation programs has centered around the most commonly used food, feed, fiber, and industrial crops of the country acquiring the germplasm. The best organized and most comprehensive system in the world for germplasm acquisition, multiplication, evaluation, storage and distribution is the one developed in the United States Mr. Bass discusses each of these areas in detail.

The presentation's conclusion is: Acquisition, storage, and distribution of a broad base of genetically diverse plant germplasm is critical to future agricultural development worldwide.

To preserve the generic variability of germplasm collections, great care must be taken to apply storage and regeneration procedures that will maintain the genetic integrity of each accession.

Cyrogenic storage and tissue culture could be valuable preservation methods in the future provided suitable procedures can be developed for individual species.

Seed Laws, Certification And Testing For A Developing Native Seed Industry

Rodger Danielson, Oregon State University, Corvallis, Oregon

This paper reviews the areas of seed laws, seed certification and seed testing for the purpose of identifying needs of a developing shrub and forb seed industry. The current status of labeling requirements for seeds other than agricultural or vegetable seeds is explained. Recently developed tree seed certification programs are described. A progress report is made on developing seed testing rules for shrubs and for seeds.

Commercial Seed Production And Sales Of Species For Revegetation

Art Armbrust, Sharp Brothers Seed Company, Healy, Kansas

This is a historical review addressing native species of grasses and forbs, beginning with the origins of the revegetation industry during the dust bowl era on the Great Plains. At that time plant materials were collected and established without consideration for species or ecotype adaptability or desirability.

Since that time the industry has developed techniques for the controlled production of some forbs and flowers, and continues to make advances daily. It is, however, still dependent on "wild land" harvests of several species of grasses and many of the shrub plants utilized in vegetation today.

Because of heavy government involvement, seeds for revegetation are sold in a different manner than are most other crop seeds. Today, much of the seed sold continues to be sold to agencies and industry on a bid or contract basis. Major changes are not seen in this approach.

Seeding Rangelands With A Land Imprinter And Rangeland Drill In The Palouse Prairie And Sagebrush-Bunchgrass Zone

M.R. Haferkamp, R.F. Miller, and F.A. Sneva, USDA Agricultural Research Service, Squaw Butte, Oregon

The land imprinter developed by Robert M. Dixon, USDA-ARS, appears to be an effective implement for covering broadcase seed as well as producing micro-depressions in the soil that improve water infiltration. Results have been good in the southwestern United States, where much of the precipitation occurs as intense summer rains. In the northern sagebrush-bunchgrass zone, where over one-half of the precipitation falls as snow and spring rain and most seedings are fall planted, the rangeland drill has traditionally been used. Data comparing the imprinter versus the rangeland drill in the northwestern United States have been lacking. This study, initiated in 1982, compares the effectiveness of the land imprinter versus the rangeland drill for establishing Nordan crested wheatgrass (Agropyron desertorum) in the fall.

Imprinting for fall seeding did not improve seeding success in these studies. However, the practice produced stands comparable to drilling on loose seedbeds. The method may be a viable alternative to drilling on loose seedbeds produced by disking and other disturbances or where drill rows are viewed as aesthetically unappealing. Economic differences between seeding by the two techniques were not fully evaluated, but the water-filled land imprinter probably requires more horsepower than a comparably sized rangeland drill.

Depth Of Interseeding Scalps Can Affect Growth Of Seeded Mountain Big Sagebrush

Richard Stevens, Utah Division of Wildlife Resources, Ephraim, Utah

One means of establishing desirable species into grass stands interseeding, which includes removing competitive vegetation from selected areas or spots and seeding in desirable species. Removal or reduction of vegetation allows for establishment of seeded species.

Studies including three types of scalpers and various species showed that the size differences in big sagebrush (Artemisia tridentata ssp vaseyana) plants became evident after 5 years. Height and crown of mountain big sagebrush plants varied with scalp depth within each row. The smallest

shrubs occurred in the deepest and most abundant part of each row. The largest plants occurred where the scalps were only one-to-two inches deep. Shrub size decreased as scalp depth increased. The largest seeded sagebrush plants were those established on top of the scalp berms. Moisture was not a limiting factor, but nitrogen may have been.

Felxing Roller For Disk-Chains

Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, Texas

The research disk-chain developed by the Texas Agricultural Experiment Station for the preparation of seedbeds on rangeland used 2-inch anchor chain, 24-inch disk blades, and was 24 feet wide. Research to determine the influence of operating mass on draft and soil penetration necessitated the use of two-and-one-half and three-inch chains. These larger chain sizes resulted in widths of up to 41 feet using the same number of disk-blades (20) as the original research unit. A flexing roller that would telescope to different widths was designed using a a 20-inch diameter roller to overcome the breakage problem of the original 12-inch (pipe) roller. A ridged pipe brace with clevis connections was necessary between the flexing joint and the triangular tow plate for proper operation. The flexing joint was constructed form 1-inch plate and D-6 track carrier rollers. Preliminary pulling results indicate that the draft of the larger disk-chains will average between 250 and 500 pounds per blade. The new roller will allow extensive evaluation of different size disk-chains. This project has been funded in part by VREW.

Plants For Western Colorado, Eastern Utah And Southwest Wyoming

Sam Stranathan, Upper Colorado Environmental Plant Center, Meeker, Colorado

Some new plants for agriculture are discussed.

The Forest Service Lab, headed by Dr. Durant McArthur, initiated some revolutionary concepts in fourwing saltbush selection and production with "Rincon" (Atriplex canescens). Rincon is a mixture of six separate female lines and four male lines. A proportionate number of males and females are used to establish new orchards.

In 1984, the Meeker Plant Center released a slender wheatgrass named "An Luis." This Agropyron trachycaulum is to be used primarily on disturbed sites at higher elevations. It was selected for its performance on high altitude sites associated with hard rock mining where it displayed longer than average span.

Based on good performance at some pretty tough planting sites a strongly spreading type of Louisiana sage (Artemisia ludoviciana) called "Summit" was selected for the first ecotype to be released.

The plant center at Meeker is growing the hottest new Crested wheatgrass since "Nordan." This Agropyron desertorum-Agrophyron cristatum cross called "Hycrest" has a track record that is quite exciting.

Recent Plant Releases For Western Wildlands

Richard Stevens, Utah Division of Wildlife Resources, Ephraim, Utah, and Stephen B. Monson, USDA Forest Service, Provo, Utah

Recently, some useful broadleaf herbs and shrubs have been released for range and wildland plantings. These items have been under study for 25 years and provide additional species useful for planting disturbed wildlands. This is an in-depth report of the features, uses, and areas of adaptation of three more recently released cultivars. More specific information on he three selections, "Hatch Winterfat" (Ceratoides lanata), "Cedar" Palmer Penstemon (Penstemon palmeri var. palmeri) and "Immigrant" Forage Kochia (Kochia prostrata) is available from any of the cooperative agencies involved in the release program.

Seed Harvesters–An Evaluation Of Existing Machines And Projected Needs

Stephen B. Monson, USDA Forest Service, Provo, Utah; Richard Stevens and Kent R. Jorgensen, Utah Division of Wildlife Resources, Ephraim, Utah

Seed harvesters are needed that can be operated on wildland sites, cultivated fields, seed orchards, or nurseries. To date, most seeds have been hand collected from wildland stands. Seeds of many species can and are being grown in nurseries, yet costs remain high as mechanical harvesters are not available for seed collection.

Information presented in tabular form summarizes the features and operational capacity of the nine collectors that have been most widely tested. These include: truck-mounted, jeep-mounted, Mec Tighe backpack, DSI backpack, air-amplifier, Echo PB400 Blower, Solo Power Blower, Insect Collector, and Elephant-Vac.

In 1984, a survey was conducted to better determine the needs and type of seeds being harvested. In addition, it was determined which seeds are in demand but are not being supplied due to the lack of adequate seed harvesting equipment.

Fourwing Saltbush Seed Harvester Development–Progress Report

J.L. Halderson, University of Idaho, and C.G. Howard, USDA Soil Conservation Service, Aberdeen, Idaho

During November 1984, seed harvesting trials were conducted near Bliss, Idaho, to evaluate three harvesting methods. Mature fourwing saltbush plants, with an abundance of mature seed, were found along the interstate highway right-of-way. These plants were the result of dry seeding of drillbox mixture of seeds in the early 1970's. The plants had considerable variation in seed maturity, were intergrown with weeds, and had considerable dead wood around the skirt of the plant. The site did not entirely represent orchard conditions, but provided useful preliminary information for development of a seed harvester.

While harvester experiments in fall 1984 gave beneficial information, they were not tested in a seed orchard, so direct comparability could not be done. Vacuums of any size appear to lack power at the nozzle for authoritative seed detachment. Shaker performance can definitely be improved, and it could be adequate as a replacement for hand harvesting. If shaker development can progress to a sufficient degree, it could lead to a self-propelled, over-the-row type harvester. Combines appear unsuited for direct-cut harvesting while leaves are still green and heavy. Windrowing or later direct-cut harvesting give promise of improve results since seed-straw separation would be facilitated.

Reclamation Equipment And Techniques In Southwestern Wyoming

Fred E. Parady III, Bridger Coal Company, Rock Springs, Wyoming

Bridger Coal Company operates a surface coal mine 35 miles northeast of Rock Springs, Wyoming. Approximately 20,000 acres are under permit, with disturbance over the life of the mine projected to reach 10,000 acres. Located on the western rim of the Continental Divide, the mine receives less than 9 inches of precipitation annually. Soils in the area are coarse-textured, and problems associated with elevated salinity and sodicity are encountered.

A variety of common reclamation techniques have been modified to reflect these conditions. Soil horizons are segregated during salvage operations (the surface 6 inches as topsoil and the balance as subsoil). Unsuitable materials are not salvaged. Direct application of soil is used to maximize native plant regeneration and conserve soil fertility. Interseeding of seeding failures has proved to be significantly more successful than chisel plowing and reseeding. Broadcast seeding has been ineffective because of strong winds, and a no-till drill has been modified to handle diverse seed mixes and rock conditions. The utility of fertilization under typically xeric moisture regimes is being evaluated.

Many of the initial concerns over reclamation feasibility in a semiarid desert environment have been laid to rest. Improvements have occurred in soil management, shrub establishment, and farming operations. Reclamation has been successfully achieved in areas receiving less than 10 inches of precipitation.

A Colorado Regulatory Perspective On Reclamation Of Lands Mined For Non-Coal Minerals

Mark S. Loye, Colorado Mined Land Reclamation Division, Denver, Colorado

The Colorado Mined Land Reclamation Act of 1976 established a statutory framework mandating reclamation of lands mined for non-coal minerals, while allowing for the continue development of mining in Colorado.

Emerging issues for the Minerals Program include the continuing growth in the number of active mines while staffing levels for the section remain essentially constant; the growing clash between increasing urban sprawl and mining; and the growing number of defaulting mine operators that results in the forfeiture of reclamation bonds by the Mined Land Reclamation Board. The division must make arrangements to reclaim those lands covered by the forfeited reclamation bond monies.

Despite the tasks to be accomplished, there are signs that the Mineral Program is succeeding in its mission of reclaiming all lands mined for non-coal minerals in Colorado. The eventual goal is for mining and reclamation to be integrated into one process.

Western Reclamation Group Update

Thomas A. Colbert, Intermountain Soils, Incorporated, Denver, Colorado

The Western Reclamation Group (WRG) was formed by a small group of people at the VREW meetings in Tulsa in 1981. These people shared a common concern about problems with regulation of coal mine reclamation under what was then a still relatively new federal law called the Surface Mining Control and Reclamation Act of 1977.

Early accomplishments of WRG were the identification of current technological issues surrounding western coal reclamation and of shortcomings inherent in the new regulatory system that sometimes hindered attempts to find or use better methods in reclaiming mined lands. The effort culmintated in a symposium in Denver in 1983. Copies are available of the proceedings.

At this time, four general areas of concern have been identified, and most WRG efforts will probably focus within these areas:

1. Determination of overburden quality;
2. Characterization and use of topsoil;
3. Plant species establishment; and
4. Reclamation success standards.

Interested VREW participants are encouraged to contribute by working on technical papers or serving on a committee.

Terra-Torch

Glen Secrist, USDI Bureau of Land Management, Boise, Idaho

Field tests indicate that the Terra-Torch is an efficient and cost-effective device for use in fire management where access is limited or where particular burn patterns are desired. The 60-to-100 foot arc capability makes burning slash piles or log decks on steep roads possible. Fuels can be pretreated with the Alumagel, then ignited, producing 20-foot flame heights and generating heat of 2,000 degrees F. Two people can blackline an area that would require the efforts of a large crew. Conceivably, costs could be recovered in one or two missions.

Mechanical Equipment For Brush Cutting And Slash Treatment

Dan W. McKenzie, Range Scientist and Mechanical Engineer, USDA Forest Service, Equipment Development Center, San Dimas, California

This article gives sources of mechanical brush cutting and slash equipment, and gives field equipment selection criteria for mechanical brush cutting and slash equipment.

Additionally, the Forest Service San Dimas Equipment Development Center has prepared an update to the 1978 publication on mechanical equipment for brush cutting and slash treatment entitled "Field Equipment For Precommercial Thinning And Slash Treatment." This update lists current information on mechanical brush cutting and slash treatment equipment.

The first section lists mechanical slash equipment and a second section gives criteria to consider when selecting heavy-duty equipment for brush cutting and slash treatment. The third section lists, in tabular form, one-line summaries of 75 field projects in which equipment described in the first section was used.

Dry Herbicide Pellet Application

Robert Gaylord, Elanco Products Company, Flagstaff, Arizona

There is a continuing need for some type of ground equipment that can be used to broadcast pelleted herbicides at low rates (0.5-1.0 lb/ac) and still provide uniform distribution at reasonable cost. Advantages of aerial and ground application of pellets are given and, to illustrate the present state of equipment development, Gaylord reviews the Model F1 Forestry Pelleted Material Applicator from Omni Spray, Inc., Prattville, Alabama.

Sheep Bridge On A Budget

Paul J. Butler, USDA Forest Service, Twin Falls, Idaho

In 1983, when it was determined the Rock Creek sheep bridge would have be replaced, a conventional bridge design was selected using 36-foot steel bridge stringers and a center support. To hold down costs, best buys were sought on the two steel "I" beams that were 6 inches high, 4 inches wide, and weighted 16 pounds per foot, as well as the prefabricated steel parts such as lateral braces, center supports, bolts. The wooden decking, abutment material, and railing were obtained from salvaged materials. All materials were pressure-treated when new.

The new Rock Creek Sheep bridge cost $2,323 compared to a prefabricated bridge which costs a minimum of $5,100-to-$6,000. The article gives explicit information.

Fence Failures At Dog Legs And What To Do About Them

Dan W. McKenzie, Range Scientist and Mechanical Engineer, USDA Forest Service, Equipment Development Center, San Dimas, California, and Bret Eisminger, KIWI Fence Systems, Inc., Waynesburg, Pennsylvania

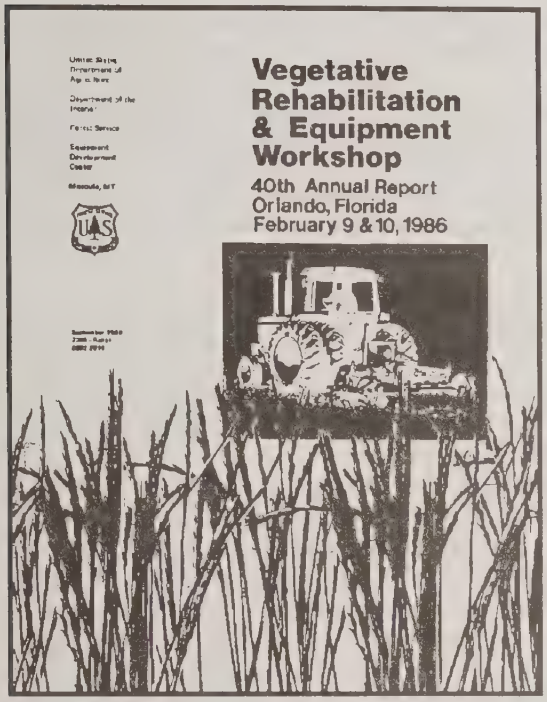
Standard barbed wire fence failures at dog legs are not as critical as with high-tensile smooth wire fencing, which requires the complete fence to be maintained at the proper tension to be effective.

Fence failures at dog legs are caused by the strainer length being less than critical length. The pull-out problem at dog legs can be eliminated by placing a diagonal strainer bisecting the dog leg angle with an actual length greater than the critical length. If the dog leg is 60 degrees or less, signed to Forest service Nationwide Forestry Applications Program, Houston, Texas

The Agricultural and Resources Inventory Surveys through Aerospace Remote Sensing (AgRISTARS) Program was initiated in 1980. The program goal is to determine the usefulness, cost, and extent to which aerospace remote sensing data can be integrated into existing and future USDA systems to improve the objectivity, reliability, timeliness, and adequacy of information required to carry out USDA missions.

One of the program's major efforts has been to improve the capability of using high-altitude photography for applications in resource management. These applications deal primarily with the use of color infrared (CIR) aerial photography.

The major emphasis in the Nationwide Forestry Applications (NFA) Program has been on applications for using high altitude photography (flown over 50,000 feet). High altitude photography is one approach that has been cost-effective not only for rangeland applications, but for other resource applications. Some of the elements that have the potential for being extracted through the interpretation of high-altitude aerial photography are: land cover, biomass, landform, vegetation, and condition (e.g. stress mortality), detection of springs and other areas for potential water development, mapping of manmade features, and monitoring change over time.



1986 Vegetative Rehabilitation And Equipment Workshop 40th Annual Report

Orlando, Florida

Reclamation Status–Past, Present And Future

Dr. David J. Robertson, Florida Institute of Phosphate Research, Bartow, Florida

Phosphate mining in the Pebble District of central Florida began about 1880 and has had a history of almost continuous growth since then. Mining began with dredging operations in the Peace River, then moved on-shore to exploit the rich land pebble deposits. Land pebble was first mined hydraulically until the 1920's when electricity draglines supplanted high-pressure water. Since the turn of the century, central Florida has assumed world leadership in the production of phosphate rock. Land disruption has paralleled the rate of mining and has become increasingly visible.

Two additional developments contributed to reclamation problems, the introduction of hydroclones to separate clay-sized particles from sand-sized particles, and the universal adoption of flotation to recover sand-sized fine fraction of the phosphate matrix that had formerly been discarded.

There is an increasing interest in re-establishing native rangeland instead of improved pasture on reclaimed land. Other options to be examined for reclaimed lands include row-cropping, and establishing citrus groves and pine plantations. Wetlands, streams and lakes are being studied to determine the possibilities of rehabilitation.

Phosphate Mine Reclamation–Laws, Regulations and Policy

Jeremy A. Craft and James W. (Bud) Cates, Florida Department of Natural Resources, Tallahassee, Florida

The phosphate industry is regulated by a variety of state, regional and local agencies in Florida. The Department of Natural Resources Bureau of Mine Reclamation is responsible for the review and regulation of all reclamation activities. The Department of Environmental Regulation regulates mining and, for mitigation purposes, the reclamation and restoration of wetland areas. The regional water management districts are beginning to implement regulation for the management and control of surface waters. They already regulate the consumptive use of groundwater. The regional planning councils, in conjunction with the local governments, review new mines and large expansions of existing mines through the development of regional impact programs. Local governments also require annual mining and reclamation approvals.

The Bureau of Mine Reclamation is divided into three sections. The mandatory section is responsible for the review of reclamation programs on those lands mined after

July 1, 1975. Lands mined since that date are subject to a mandatory requirement for reclamation. The mandatory rules address land use in much more limited and defined terms than under the non-mandatory program.

The non-mandatory section allocates a portion of the non-mandatory land reclamation trust fund each year to provide incentive grants to reimburse landowners for the reclamation of those lands mined previously to July 1, 1975.

The technical support section was recently created to study problems within the mining industry, such as clay consolidation, surface water, and groundwater hydrology, and to provide support to the other two sections in the evaluation and analysis of reclamation programs.

Use Of Fire As A Tool To Manage Vegetation

Bill Lennhouts, US Fish and Wildlife Service, Titusville, Florida

The Merritt Island and St. Johns National Wildlife Refuge has been expanding its prescribed fire operations since the 1970's. Since that time, prescribed fire has expanded into a complex program involving over 50,000 acres and encompassing many vegetation types, some of which are fire adapted and some that are not. The objective of this report is to illustrate the response that different vegetation types have to fire and how this knowledge is used in management decisions.

The vegetation types of Merritt Island and St. Johns National Wildlife Refuge can be subdivided into those which have frequent fire intervals: flatwoods, grass marsh, palm savannah; those which have infrequent fire intervals: scrub, coastal strand, coastal dune; and those that are non-fire types: hammocks, swamp, ruderal. The report gives descriptions, summaries of the fire response and management options for each of the vegetation types.

Wetland Grazing Management And Improvement On The National Forests In Florida

William C. Bodie, USDA Forest Service, Tallahassee, Florida

This report gives an overview of the wetlands situation on the National Forests in Florida, particularly as it applies to the program of range management. Bodie describes the general wetlands resource management situation in Florida as affected by laws and regulations, gives the National Forest perspective of its wetlands, and explains a few resource management practices favorable to grazing on, or adjacent to wetlands.

Methods addressed include prescribed fires, site preparation for forest regeneration, and soil conditions.

New Seed Drill

Robert A. Teegarden, USDI Bureau of Land Management, Billings, Montana

A new seed drill is in its later stages of development. BLM is testing two of the drills designed and built by the Truax Co., Inc. of Minneapolis.

The machine can be generally described as a nine-tooth, heavy-duty chisel plow with the chisels placed on 10 inch centers. Mounted on each chisel shank are 4.5 inch spades. This gives 40 to 50 percent soil disturbance. Approximately one-half of the disturbed soil is thrown over the undisturbed sod strip. The seed drop tubes and the packer wheels are in line with the chisel shovels. This allows the seed to be dropped in the furrow and the packer wheel to then press the seed into the soil.

Coated Seed As A Tool For Revegetation

Stu Barclay, CelPril Industries, Incorporated, Hermiston, Oregon

Coated seed provides a useful tool to the revegetation manager. It allows creative seeding and can achieve results that can be accomplished in no other way. It offers a medium for any number of materials to be included in, and carried with the seed, to increase the odds for its survival and vigor.

CelPril has ongoing testing programs with state departments of transportation, Forest Service, Bureau of Land Management, and seeding contractors (USDA). Results are still pending.

Disk-Chain Performance

Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, Texas

Studies have been conducted to project the optimum size disk-chain for use on native (undisturbed) rangeland infected with shrubs. Six disk-chains with two different disk blade diameters were used to evaluate the effect of mass on draft and depth of disk penetration. Operation widths were also varied. The disk-chain with 3-inch chain and 24-inch disk

blades (204 pounds per blade operating mass) had the best overall performance based on the broad range of soil conditions encountered in this study.

Establishment Of Range Grasses On Various Seedbeds At Four Creosotebush Sites In Chihuahua, Mexico, and Arizona, USA

M.H. Martin and F.A. Ibarro, Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora, Mexico; J.R. Cox and H.L. Morton, Agricultural Research Service, Tucson, Arizona

Three creosote bush study sites were selected in northern Mexico and one in southeastern Arizona. Treatments included mechanical, chemical, and untreated check. Seven varieties of grasses were hand broadcast and seeded.

Successful plantings were obtained in Arizona in both 1981 and 1982, and at the site in Mexico in 1981. Plantings were unsuccessful in Mexico in 1982 because of extremely low rainfall.

In 1981 seedling establishment and forage production at the four sites were superior on disk-plowed and disk-plowed and contour furrowed seedbeds, intermediate on chemical seedbeds and least on two-way railed and land imprinted seedbeds. Kleingrass and sideoats grama were most abundant at sites that received summer precipitation, while Catalina and Cochise lovegrasses were most abundant at sites that received both summer and winter precipitation. Because of very dry conditions in 1982 and 1983, most of the species planted in two Mexican sites died. Plant establishment was greater when seeds were broadcast on the surface of mechanically prepared seedbeds.

The Use of Fire, Grazing Livestock, Insecticides, And Plant Gerplasm To Control Spittlebug In Buffelgrass Pastures Of Northern Mexico

I. Cazares, M.H. Martin and F.A. Ibarra, Centrol de Investigaciones Pecuarias, del Estado de Sonora, Hermosillo, Sonora, Mexico; and J.A. Morales Instituto Technologico y de Estudios Superiores de Monterrey, Monterrey, Nuevo, Leon, Mexico; and H.L. Morton and J.R. Cox, Agricultural Research Service, Tucson, Arizona

Buffelgrass (Cenchrus ciliaris), a perennial bunchgrass, was introduced into Sonora, Mexico from the United States in 1954. Spittlebug (Aeneolamia albofasciate) feeds on buffelgrass and its populations have dramatically increased in Sonora as a result of above average precipitation. Feeding spittlebugs can significantly reduce the quality and quantity of buffelgrass forage and may, in some instances, kill plants.

The following studies were initiated in 1984-85 to determine their effects on the spittlebug populations and the productivity of buffelgrass: application of fire, grazing management, application of insecticides and development of buffelgrass accessions resistant to spittlebug.

Preliminary results indicate that:

1. Burning before the rainy season or in the early stages of the spittlebug life cycle has caused the most damage to both eggs and nymphs;

2. A rotation grazing system that removed about 60 percent of the biomass during the summer growing season has destroyed the environmental conditions required for the spittlebug development;

3. Early application of insecticides between the first and fourth instar stages are more effective than application in the adult stages; and

4. One or two accessions that are easily established will be selected later to determine if they are more resistant to spittlebug feeding and reproduction than common buffelgrass in Sonora.

Chemical And Mechanical Brush Control And The Response Of Native Grasses In The Chihuahuan And Sonoran Desert

F.A. Ibarra and M.H. Martin, Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora, Mexico; and H.L. Morton and J.R. Cox, Agricultural Research Center, Tucson, Arizona

Creosotebush (Larrea tridentata), either alone or in combination with other shrubs, infests from 18 to 26 million hectares in the southeastern United States and 45 million hectares in northern Mexico. Chemical and mechanical treatments were applied during the summer of 1981 and 1982 at three field sites in Chihuahua and one in Arizona. Treatments were evaluated for creosotebush mortality and forage production for three growing seasons after treatment.

Data obtained for both brush mortality and forage production were varied within locations, between locations and years of application due to different soils, vegetation and climate. Creosotebush infested rangelands in the southwestern

United States and northern Mexico can be converted back to productive semi-desert with chemical and mechanical practices.

Mechanical Plant Control

Gus Juarez, USDI Bureau of Lan Management, Grand Junction, Colorado

The Beckwourth and Quincy Ranger Districts of Blairsden and Quincy, California on the Plumas National Forest operated a Madge Rotoclear land breaking machine under contract this last summer. The machine was pulled by a Caterpillar D-6 tractor. Operating speed was just over one mile per hour, which resulted in a production rate of one-half to three-fourths of an acre per hour. The unit was able to operate in ground containing a fair amount of rocks surprisingly well.

Problems with the machine were: the great amount of dust; loss of teeth; and the machine operator's lack of preventative maintenance before being placed into operation. After a heavy rain the dust problem did not exist. A US contractor is operating three of the units, and cost of operation, depending on location and size of job ranges from $100 to $200 per hour, or $100 to $175 per acre.

Avery Stroke-Control Device For Windmills

Robert G. Childress, USDA Forest Service, Hot Springs, South Dakota

An ingenious device that increases the capability of a windmill to pump water has been invented by Don Avery, Professor Emeritus of Mechanical Engineering, University of Hawaii. It automatically controls the length of a windmill's stroke to increase the amount of water pumped when windspeed increases. The device uses the additional power of increased windspeed to change the length of the windmill stroke, increasing the amount of water pumped to about four times that of a conventional windmill under the same amount of wind.

A prototype made by Dempster Industries of Beatrice, Nebraska, produced about 17 gallons per minute in a 15 mph wind, versus four gallons per minute without the device. The stroke varied from 2 to 16 inches with the unit.

It should be possible to install a commercially manufactured kit for considerably less than $1,000.

Diagonal Fence Strainer Use And Other Fence Developments

Dan W. McKenzie, Range Scientist and Mechanical Engineer, USDA Forest Service, Equipment, Development Center, San Dimas, California

The diagonal fence strainer, which is equal in strength and holding force to the horizontal fence strainer but is lower in cost to install is gaining in use. When using the diagonal fence strainer two important rules should be followed:

1. Be sure that the end of the diagonal brace in contact with the ground is free to move forward and is not blocked by a stake or post; and,

2. Make the diagonal brace as long as possible (at least 8 feet; 10 feet is better, and if possible, go 12 feet). This rule applies to the horizontal strainer also.

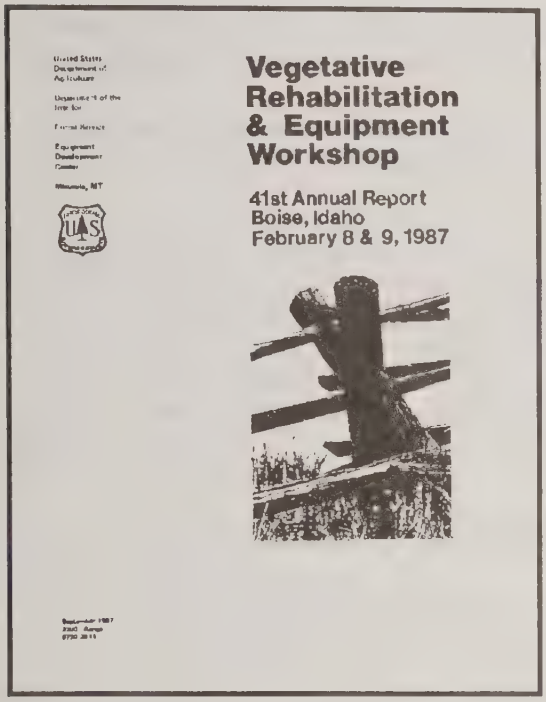
Good use can be made of the diagonal strainer to prevent failures at dog legs by placing the strainer so that it bisects the dog leg angle.

The need for double horizontal and diagonal strainers appears to be unnecessary if soundly constructed 10 to 14 feet long, thus eliminating their added cost.

A design of line strainer that allows a significant reduction in the amount of construction labor and material is the tension member line strainer. It requires only one post hole to be dug, and the use of only one post; the bottoms of the next posts are used to anchor the tension members.

Recently the Aligned Fiber Composites Co. of South Chatfield, Minnesota, completed the development of a fencing system using fiberglass posts and specially designed hardware. A very good installation manual can be obtain upon request.

Volumes include: "Handling, Sheltering, and Trailing Livestock"; "Fences"; Water–Pumping and Piping"; and "Water–Damming and Storing."



1987 Vegetative Rehabilitation & Equipment Workshop 41st Annual Report

Low-Volume Irrigation Pumping With Wind Power

R.Nolan Clark, Agricultural Engineer, Southern Plains Area Conservation and Production Reserach Laboratory USDA Agricultural Research Service, Bushland, Texas

Water-lifting windmills may serve as an alternative to engine-driven pumps for low-volume irrigation systems. A recent research approach to improving the over-all efficiency of the American windmill is the variable stroke mechanisms.

A comprehensive laboratory and field study on the american multi-bladed windmill has been started November 1986 by the Agricultural Research Service ast the USDA Conservation and Production Research Laboratory, Bushland, Texas with the following objectives:

1. To develop pumping and efficiency curves of the conventional windmill under different windspeeds and loads;

2. To test different variable stroke mechanisms in an effort to improve over-all efficiency and to increase total volume of pumped water;

3. To model the windmill performance and study the feasibility and cost effectiveness of the improved units; and

4. To evaluate the potential of pumping water for low-volume irrigation systems, particularly drip systems.

Range Structural Improvement Handbooks

Richard J. Karsky, Agricultural Engineer, USDA Forest Service, Equipment Development Center, Missoula, Montana

As part of the continuing effort to provide information to land managers about suitable revegetation techniques and equipment, the Vegetative Rehabilitation and Equipment Workshop has consolidated structural improvement handbooks, now scattered through several federal agencies, into four volumes. Each volume describes a facility's components, uses, advantages and disadvantages. It presents information on costs, safety, and environmental concerns and construction features. Where applicable, suggestions for redesign or new concepts for future development are included. Pertinent books and articles are cited.

Common Sense Fencing

Billy H. Hardman, Range Implementation and Special Programs, USDA Forest Service, Region 1, Missoula, Montana

New design and materials have made possible a concept in fencing that out-performs barbed wire and woven wire by a factor of at least four-to-one in all areas of animal control, maintenance, effective product life, installation requirements and cost. The Common Sense Fence (TM) is the first permanent, multiple wire, long distance electric fence capable of providing 20 to 30 years of reliable, low-maintenance service.

Four major advancements have been designed for this fencing system. They are:

1. A complete fiberglass self-insulating wire support system;
2. Latest solid-state electric technology controller;
3. Heavily galvanized 12.5 gauge high-tensile wire; and
4. Free-flowing spring-clip for attaching wire to posts.

Fence Developments

Dan W. McKenzie, Range Scientist and Mechanical Engineer, USDA Forest Service, Equipment Development Center, San Dimas, California

Two new fence developments affect dog containment and double fence braces.

The Invisible Fence Company of Wayne, Pennsylvania, markets a fencing system that is not visible and is designed to contain dogs within a given area. Elements of the system include a thin wire buried in the ground, a small radio transmitter, a lightweight leather dog collar and a conditioning or training program for the dog.

In constructing either a diagonal or horizontal fence brace, calculations indicate that a single brace 11 feet long (5.5 times average wire height) or longer is as strong or stronger than a double brace with two 8-foot panels. These calculations indicate that the need for double fence braces is unnecessary and their added cost is not justified provided that the members of a single brace are strong enough to carry the applied loading.

Portable Data Collection Field Terminals: Selecting The Best One For Your Needs

Meg Frantz, Applications Engineer, Omnidata International, Incorporated, Logan, Utah

Electronic recording devices remove the difficulties encountered with traditional methods of collecting data in the field. The portable models, when housed in suitably rugged cases, can withstand the rigors of the outdoors. Since the data is recorded in digital form, it can be transferred directly to computer through a cable. This capability means that no one has to digitize from charts or keypunch from field sheets, which results not only in savings of time, but also increased data quality.

Mechanical Control

Mark Mosely, Range Conservationist, USDA Soil Conservation Service, San Angelo, Texas

Texas offers a stage for using a variety of mechanical brush control practices. Different brush that requires different methods of control occurs on each major land resource area of Texas. The most important consideration for planning brush control is the desired objective. The needs of wildlife, kinds of livestock to be run, production goals, future land values and financial resources influence the managers decision.

Explored are: rootplowing, treedozing, chaining, rollerchopping, shredding, low-energy grubbing, and treatment, carpet rolling, and disk-chaining.

Chemical Control

Pete W. Jacoby, Professor, Texas Agricultural Experiment Station, Vernon, Texas

Despite many restrictions limiting their use, herbicides remain a key method of controlling unwanted plants in range and pastureland.

Herbicides are popular with landowners because they are cost effective, quickly applied, selective in the plants controlled and non-disturbing to the soil surface. The purpose of this presentation is to discuss the more prevalent herbicides available for rangeland use and their status and attributes.

Seeding Chaffy Grass Seed And Grass Seed Mixtures

Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, Texas

A chaffy grass seed metering device developed by the Texas Agricultural. Experiment Station has largely overcome the severe dispensing problems associated with these grasses. The semi-circular seedbox, auger agitator and pickerwheel metering system has easily metered 97 percent of seed from the seedbox at relatively uniform, predictable rates for seven notoriously hard-to-seed grasses. To seed mixtures with both chaffy and slickseeded grasses, two separate seedboxes and metering systems are required.

How To Provide Range Improvement Information To Users

John Vallentine, Utah Division of Wildlife Resources, Great Basin Experiment Station, Ephraim, Utah

A general list of available information concerning special treatments, structures, and developments for rangeland that needs to be presented to range technicians, ranchers, public land managers and administrators, agribusiness personnel, service/support, educators, and students. Suggested continuing and future activities are given for VREW.

Equipment Development Needs

Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, Texas

Much of the equipment developed for range improvement on federal lands, and more especially equipment design project, were undertaken with little regard to economics. Consequently, range improvement practices were gradually de-emphasized, especially during the high inflation period of the 1970's and the cost accounting emphasis of the 1980's. As a judgmental factor, we must ask ourselves, "How much of the equipment designed by VREW has ultimately been utilized by the private sector?"

The key to VREW's survival is innovative approaches. These include development of both equipment and techniques for effective rangeland improvements. Short-term action may necessitate publication of current technology, but long-term stability will require new technology. Many new demands will be placed on federal lands by the public and cost accounting will be ever present; however, this will open many new opportunities. We should be considering challenging new alternatives for future rangeland improvements from a wholistic viewpoint.

Develop And Test Disk-Chain Implement

Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, Texas

The objectives of this study were:

1.(a) To compare the disk-chain draft requirements of the triangular and diagonal pulling techniques;

(b) To improve the design of the triangular systems;

2. Determine the draft requirements and depth of cut of six disk-chains of different operating masses in disturbed rangeland soil and undisturbed, native rangeland of clay loam and sandy loam types.

The angle of pull selected as optimum for the triangular pulling technique was 60 degrees with a flexing joint centrally located in the rolling brace to allow necessary vertical movement on rough land surfaces.

Draft per blade was significantly different for each disk-chain and was positively correlated to operating mass per blade for each soil condition. Based on the broad range of soil strengths encountered in this study, the disk-chain with 3 inch chain and 24 inch disk blades would give the best overall performance. Expected depth of operation of a broad range of conditions can be predicted most accurately by equation.

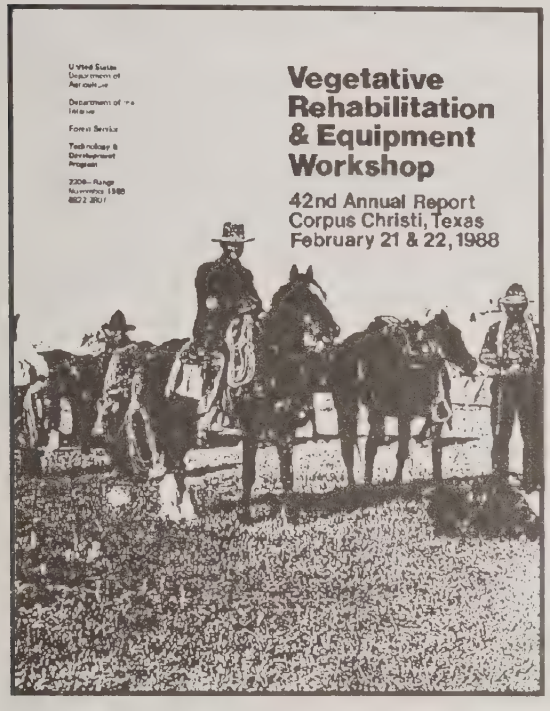
A Progress Report On The Disk-Chain For Revegetating Rangeland

Robert Knudson, USDA Forest Service, Equipment Development Center, Missoula, Montana

The Missoula Equipment and Development Center (MEDC) began evaluating a disk-chain in 1984. The same year a contract was awarded to the Texas A&M Experiment Station to continue development on the disk-chain.

Knudson's report traces steps in development of a disk-chain device built by MEDC, tested by Intermountain Station in Utah, Nevada, and Idaho, and subsequently modified by MEDC. The implement was further tested for greenstripping in southern Idaho. Disk breakage and weld breakage were continual at this point.

In FY 1987 BLM Boise district funded MEDC to build a different disk-chain. The Boise District shop is building the implement, and delivery is expected in October 1987.



1988 Vegetative Rehabilitation And Equipment Workshop 42nd Annual Report

Corpus Christi, Texas

Range Research In Texas

Joseph L. Schuster, Professor, Head of Department of Range Science, Texas A&M University, College Station, Texas

The goal of the Texas A&M University's range management program is to generate basic biological information and management practices useful in rangeland production systems.

Long-term management research objectives are:

1. Develop technologies that will increase production efficiency, reduce risk, and conserve the range resource;

2. Effectively integrate range management systems into operation objectives of the ranch firm; and

3. Develop practical, ecologically sound, and economically viable management alternatives for major range production areas of the state.

The strategic planning process used by the Texas Agricultural Experiment Station calls for development of prioritized research needs utilizing producer, extension, and other service agency inputs. The current research plan identifies the following major needs in range research:

1. Develop technologies for improving range plants and communities;

2. Develop flexible strategies for multiple use of rangeland resources;

3. Improve water conservation and erosion control on rangeland watershed;

4. Manage brush, weed and toxic plants on rangeland;

5. Develop technologies for optimizing livestock and wildlife production on rangeland; and

6. Develop improved methodology for resource classification and inventory.

The research approach adopted to meet these needs utilizes:

1. A systems approach to rangeland management;

2. Insures integration of range management systems into operational objectives and capabilities of the ranch firm; and

3. Includes all products and uses of the range in an interdisciplinary effort.

Information generated by the research teams is filtered through economic analyses to isolate economically sensitive variables and identify economically viable technologies. Viable alternatives emerging from this process are made available to ranch owners and managers in the context of new technology and management decision aids.

Garrison Seed & Company, Incorporated

Art Stoy, Sales Representative, Garrison Seed & Company, Incorporated, Hereford, Texas

Mr. Stoy gives an overview of the seed business and discusses present seed supplies to the CRP programs.

In the past two or three years, there have been plantings of grasses with the sole purpose of producing seed for the CRP programs. In addition to the native and domestic harvests of 1986-87, there was quite a stockpile of certain grass seeds that had accumulated in the several years preceding the advent of the CRP program. As a result of this stock pile and a good many lean agricultural years (economically), the grass seed prices were extremely low, selling at or below cost in many instances. But with the sudden demands on the industry, this soon changed and the prices sky-rocketed with the demand. Also in the confusion of getting supplies together, many new names and faces began to show up in the seed business. These people added greatly to the supply of seed, but also to the confusion.

According to the author, two factors are involved with those who have recently entered the seed business. First of all, the demand by the CRP for seed is great, creating a supply and demand that has temporarily escalated prices to a very high level. These newcomers to the business have helped to make it even higher. Secondly, the agencies involved in seed law enforcement have not been able to keep pace with the increase in demand for their services. As a result, it is doubtful that many of these new people in the industry have been subject to any amount of policing, if any at all. this creates an unfair seed law enforcement situation in the author's opinion and he feels something needs to be done to provide fairer enforcement of the seed laws, both federal and state. The author feels everyone involved in the process of accumulating and marketing of seed for the CRP (or any other program) should have to operate under the same set of rules.

Impact Of CRP On The Seed Industry

Art Armbrust, Representative, Sharp Brothers Seed Company, Healy, Kansas

The impact of the CRP program on the seed industry is very significant. It has had a dramatic impact on the grass seed industry in particular. The program has increased the demand for perennial grass, both warm and cool season, native and introduced, dramatically.

With no more than 6 months lead time, this program would have had a significant impact on animal crop seed supplies, but the demand has been for prenninials and it takes the seed industry a minimum of two years to respond to an increase in demand of this magnitude.

There are several reasons that the seed industry is not in a position to handle these large demand increases. The grass seed industry tries to produce for market demand, and over the past 10 years there were no economic incentives to increase production. Other reasons for the response were that it is a politically conceived program and industry learned long ago not to react until it sees something concrete and properly funded. The industry also received poor "reads" from the early sign-up. Government employees and people in charge of programs could certainly stabilize their specifications so that we know how to respond.

Another factor for the early confusion on the part of the industry was that species and variety requirements and amounts were unknown. Continued funding of the program was uncertain. If people who develop these programs could study them out a bit, be specific on specifications and requirements, and develop dependable funding, you would not see the sharp price fluctuations currently happening.

New Caterpillar Tillage Tractor Combines Features Of Wheels And Tracks

Bill Reno, Sales Representative, Caterpillar Incorporated, Peoria, Illinois

Caterpillar, Inc. recently introduced the Challenger 65, a 270 gross horsepower all-purpose farm tractor with a unique traction system.

The Challenger 65 combines the speed and mobility of wheels with the improved traction and flotation of tracks. The machine rides on flexible rubber belts, reinforced with continuous strands of steel cable bonded into the rubber. Rubber lugs on each belt provide higher traction than tires on comparable four-wheel drive tractors.

The traction system spreads the tractor's weight over more area, so it compacts less. At the same time, the broad, rubber belt surface gives better traction than wheels, slipping less. The Challenger's ride is comparable to a wheel tractor due to the bogie-type suspension. Power to the tracks is never interrupted, allowing the operator to maintain complete control for smooth, even turning.

The field-proven direct injection engine is turbo-charged and after-cooled. The Challenger comes with a full power shift planetary direct drive transmission with a single lever shift.

Shifting is done in a straight-line pattern, and can be done on-the-go, without clutching, to meet changing load and speed conditions without losing tractor momentum.

The tractor also has load-sensing hydraulics that reduce strain on engine power when implements aren't being raised or lowered.

Sourcing Seed For CRP: Panel Discussion

Wendall R. Oaks, USDA Soil Conservation Service, Los Lunas, New Mexico

One of the most important impacts on plant materials the past 2 years and potential for years to come is USDA's Conservation Resource Program (CRP). The goal of CRP is to remove from production for 10 years highly erodible cropland and re-establish these areas to permanent cover.

Charts are given showing the statutes of the CRP program through the six sign-ups on February 19, 1988.

After introductory remarks, the panelists answered questions. A synopsis of answers addressed the following areas: carrying out and sustaining a quality and affordable seed program given the crisis atmosphere today; imposing more stringent regulations concerning seed quality; cultivated production of improve plant materials versus native harvest; long and short term impacts of CRP on the availability of certified seed; guaranteeing seed availability to established seed buyers, and expected changes in seed availability, seed prices and seed quality as we move into the later stages of CRP.

Benavides Ranch-Range Improvement In Mexico

Trinidad Benavides, Rancher, Nuevo Laredo, Tamaulipas, Mexico

Current Mexican ranchers began working their ranches with cow-calf operations and a continuous grazing system. The resultant loss of grasses, forbs and bushes year-by-year to undesirable weeds and brush drastically lowered carrying capacity for beef-cattle.

A vegetative rehabilitation program was begun using the best introduced grass species. An important goal was to look for the best g rasses adapted to the region.

Common buffel was established which resulted in increased carrying capacity for cattle at an important rate, but destroyed a wildlife habitat. For total management of the ranches, the best alternative was felt to be multiple-use of the forage resources to reach optimum carrying capacity for both cattle and wildlife.

A cell grazing system was started. Additionally, a rootplow was used to sow strips of rangeland to benefit both cattle and wildlife. The grazing system rehabilitates and fortifies the most nutritious and palatable grasses, forbs, weeds and brush by using the cattle as the best tool to prune desirable species in certain parts of the ranch and allows the same cattle and wildlife to seed the desirable plants over the whole ranch.

The cattle men of Mexico feel that a most important step for Mexico was achieved on May 26, 1987, when the National Cattlemen Confederation instituted an association for the management, conservation and profit of wildlife, which will begin the process of repopulating wildlife all over the country.

Greenstripping: A Proposal To Reduce Wildfires In Southern Idaho

Mike Pellant, USDI Bureau of Land Management, Idaho State Office , Boise, Idaho

Idaho BLM has initiated a fire pre-suppression program, greenstripping, to reduce the increasing economic and resource losses caused by wildfires. Strips of fire-resistant vegetation are placed at strategic locations to reduce the size and frequency of wildfires.

Greenstrips will slow down the spread of or stop wildfires before they reach catastrophic size. Plant materials used in

greenstrips retard the spread of wildfires because the strips stay green longer than annual vegetation and reduce the amount of fine fuels (annual species).

This report summarizes projects completed to date and methodologies, equipment and plants used. There are many unknowns in this effort. Only a small number of the potentially useful plant materials have been utilized in greenstrips. Equipment modifications and development could improve greenstrip establishment.

Idaho BLM is proposing a cooperative five-year research and development project called the "Intermountain Greenstripping Research Project" to develop greenstripping and shrub restoration practices.

Seeding Using The Disk-Chain And Forage Nurse Crops

B.T. Cross, Texas Agricultural Experiment Station, Vernon, Texas

Successful establishment of stands of perennial grasses on semi-arid rootplowed rangeland following aerial seeding is difficult because of the effect of erratic rainfall patterns. It was hypothesized that the detrimental effects of limited rainfall events could be buffered by seeding into a cool season cover crop (wheat) during grazing season. Our underlying hypothesis was that the cover crop, in combination with the trampling effect of cattle, would enhance seedling establishment of the aerially seeded perennial grasses by firming the seedbed and improving the seed/soil interface. Disk-chaining has been a feasible method for seedbed preparation on log littered rangeland.

Tests using various disk-chaining and aerial seeding combinations achieved good to excellent stands of wheat (>2plts/ft2) on debris-littered land. Hulled WW Spar bluestem, a warm season grass, was aerially seeded (0.5 or 1 lb PLS/ac) into grazed stands of wheat. Study results indicate the concept is feasible.

The Impact Of The Conservation Reserve Program On The Farm Equipment Industry

John M. Tye, The Type Company, Lockney, Texas

The impact of CRP varies by area. In the Northeast and in the far Southwest, CRP has had very little impact on farm equipment. Areas where there has been minor impact on the farm equipment industry include the Pacific Northwest, generally the Southeast and in the corn and soybean belt of the Midwest. The area of greatest impact has been an area we might loosely refer to as the plains states. In these areas the first sign-ups have taken large volumes of acreage out of production and generated tremendous short-term interest for seed, planting equipment and some operational knowhow.

The impact of CRP will be not only one of requiring new equipment to produce seed, plant the CRP acreage, and care for it, but also a dramatic reduction in the need for equipment when this land goes out of crop production, perhaps forever.

In the short term there has been a demand for cutters, shredders, mowers sprayers, and seed harvesting equipment. There has also been an increased interest in drills for planting.

Long-term, the equipment business is still facing a number of question marks. We know that 40 million acres removed from production will make a significant dent in the need for equipment to farm that acreage. Many of these CRP acres will remain in grass after the program ends, which may mean more cattle-related equipment.

Chaparrosa Ranch-Range Improvements In South Texas

Patrick O. Reardon, Chaparrosa Ranch, LaPryor, Texas

Approximately 10,000 acres of the Chaparrosa Ranch in the northern part of south Texas have been cleared and reseeded to Buffel, Kleberg Bluestem, Kleingrass, and other introduced species during the past 30 years. Nearly every conceivable range improvement method has been tried and during the years much has been learned.

Ranch managers have learned that range improvement is not cheap. It is a never-ending battle and it should be followed by good grazing management. Since there are many more dry than wet years in south Texas, range improvements should be done as a means of surviving drought rather than increasing stocking rate. Range improvements can and must be designed to improve wildlife habitat, hunter success and ranch income.

Based on 30 years of trials, the rootplow has proven to be the best brush-clearing tool and the carpet roller is the best treatment tool. Land cleared and developed for cattle or deer habitat improvement is done in alternating, long, narrow strips to create more "edges". Land developed to be quail habitat is treated with a roller-chopper that leaves areas of selected brush plants 10-to-30 feet in diameter. Both of these methods have proven to be best in improving the habitat and increasing hunter success, which in turn increases ranch profits.

USDA Conservation Reserve Program

Wendall R. Oaks, USDA Soil Conservation Service, Los Lunas, New Mexico

VREW has for many years, to help fulfill its mission, sponsored special workshops in conjunction with the main VREW program. In February, 1987, one such workshop titled "Plant Materials Workshop–The Influence of CRP On The Range" was held. (Agenda given.)

One of the most important impacts on plant materials began last year following the passage of the Food Security Act of 1985, which authorized the USDA's Conservation Reserve Program (CRPP). The goal of CRP is to remove from production for 10 years highly erodible cropland and reestablish areas to a permanent cover of grass, forbs, shrubs, or trees.

No program in over a decade promises to have such a wide-spread effect on plant materials and range programs.

Conservation Reserve Program (CRP)

Jim Meuman, USDA Soil Conservation Service, Washington, DC

Responding to the Secretary's request to have CRP operational within 60 days of being signed into existence, a joint Department of Agriculture training session was conducted during February 1986. CRP interim rules were published in March, and the first three sign-ups were conducted in March, May, and August of that year.

The net cost of the CRP depends on many variables including the market price of commodities, program participation, and level of production. Considering both the direct and indirect commodity program savings, the CRP is approaching a no net cost status.

The final CRP rules are expected to be published in early 1987. A major rule change being considered is a change in the definition of highly erodible cropland to make it consistent with that being used for implementing the conservation compliance provision of the Act.

Accompanying charts show the status of the CRP in each state and SCS National Technical Center for the end of fiscal year 1986.

New Plant Materials For Conservation Reserve

Jack R. Carlson, Regional Plant Materials Specialist, USDA Soil Conservation Service, Portland, Oregon

Cropland retirement programs have stimulated the development of grassland seed industry over the past 60 years. Today, landowners have a wide variety of grass, legume, and shrub species and cultivars to fit their particular needs. Accompanying is a list of plant materials available for grassland plantings for major Conservation Reserve areas.

The Type Paratill

A.O. Smith, Representative, The Type Company, Lockney, Texas

The Paratill, a soil loosener manufactured by the Type Company, utilizes uniquely designed and patented legs. The Paratill is furnished with spring swivel coulters in front of each leg that cut through trash and residue.

Compacted soil flows over the angled leg and is lifted, bent, and fractured. No mixing of subsoil and topsoil occurs; no clods are brought to the surface; and surface residue remains undisturbed to prevent erosion. Paratilled ground will stimulate root development and improve water infiltration/absorption. Deep fertilizer placement can also be achieved with the loosener.

Evaluation Of Effectiveness Of Pneumatically Seeding Slopes For Erosion Control

John Haynes, Landscape Architect, Transportation Erosion Specialist, Erosion Control land Geotextiles Unit and Thomas P. Hoover,P.E., St. Matewrials and Research Engineer, Erosion Control and Geotextiles Unit, State of California, Business, Transportation and Housing Agency, Sacramento, California

This research project was to evaluate new equipment that allows seed to be applied to slopes pneumatically. This equipment may also provide an alternative for seeding and fertilizing small areas without hydromulch.

The equipment is called a Ferti-Blast gun and is manufactured by Chowning Regulator Corporation of Corning, New York.

The Ferti-Blast gun has very good potential application in Caltrans. It will be of limited use in applying lightweight grass seed because of the short distances the seed is blown. The gun could also be used in situations where dry-applied legume seed is specified. When pneumatically applied, the seed must still be covered with mulch.

The optimum use of the Ferti-Blast gun is for refertilization of erosion control or landscaped areas. Many times the original erosion control treatments applied are satisfactory for only a few years. They decline as the fertilizer is utilized. Except for the gun itself, maintenance has all the required equipment to apply fertilizer. With the use of the Ferti-Blast, many acres could be fertilized in a very short period of time.

Goats, Their Control And Use As A Biological Agent Against Leafy Spurge

Vincent T. McElliott, Student, Montana State University, Charles N. Sundt, USDA Forest Service, Gallatin National Forest; Pete F. Kay, Professor, Weed and Plant Soil Science, Montana State University; and Kris Harstead, Professor, Range Management, Montana State University

Leafy Spurge (Euphorbia esula) currently infests more than one million hectares in North America. While goats utilize leafy spurge, they are difficult and expensive to contain. The effectiveness of electric shock collars for containment of goats was tested. The degree of use and preference of leafy spurge by goats was tested in plots consisting of brush, grass and various forb species. Goats did effectively utilized leafy spurge, but their use as a control agent is questionable. The use of radio collars was proved to be effective in containing the goats.

New Resource Tools And Equipment

Richard Hallman, Resource Planner and Range Program Leader, USDA Forest Service, Technology and Development Center, Missoula, Montana

A variety of new tools designed to make reforestation tasks more efficient and economical have recently been developed by Missoula Technology and Development Center (MTDC) engineers. The improvements are part of the continuing cooperative effort to help resource managers solve problems inherent in wildland reforestation.

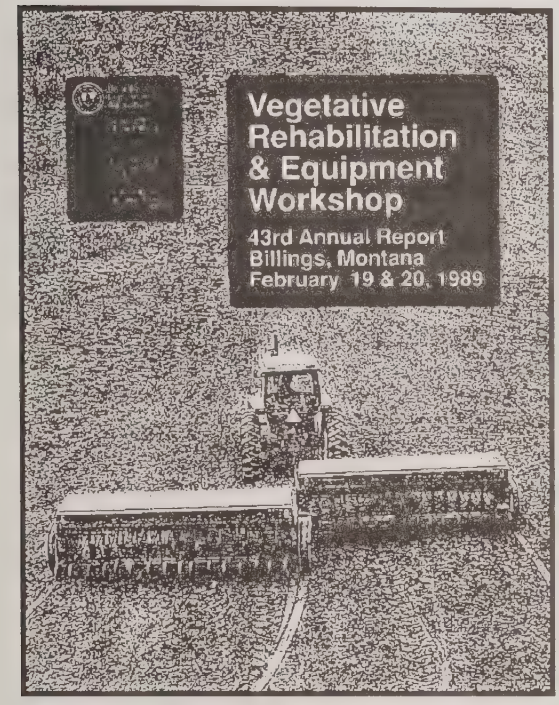
The Salmon Blade is an improved tractor-mounted blade designed for wildland site preparation. Treatment with the blade effectively kills unwanted vegetation. The Salmon Blade produces a series of furrows that catch and hold seed and water and provide an ideal microsite for regeneration. The blade rescatters slash or piles it.

The Anchor Chain Scarifer, a rugged inexpensive scarifier that features anchor chain, has been adapted for site preparation in post-logging operations by MTDC engineers. The heavy anchor-chain effectively treats light to moderate slash and prepares the ground for natural regeneration.

The Iron Horse Wood Caddy tractor is an off-road vehicle that transports equipment and supplies and provides a lightweight power source for operating implements and hand-held tools. The machine is easily operated by one person and costs about $5,500. MTDC engineers will conduct field tests in 1988 to evaluate the machine for forestry work.

A hammer-action hand planter has been designed to plant seedlings in rocky soil. Although commercial hand planters perform well in ideal soil conditions, the operator continuously absorbs the shock while operating the auger in rocky soil. Hammer-action uses an inner staff with a tool head attached The force generated by the hammer head against the staff stop drives the tool head into the ground to create a suitable planting hole.

A cone-shaped, power driven auger has proved effective in planting seedlings in rocky soils. MTDC's improved cone-shaped auger design was compared to a commercial straight-bit auger during the 1987 field season. The auger performed well, but was heavier than the commercial straight-bit augers. User comments led to a final auger that is comparable in weight to a commercial auger. Commercial production of the cone-shaped auger is anticipated.



1989
Vegetative Rehabilitation & Equipment Workshop
43rd Annual Report

Billings, Montana

Rangeland Drill

James A. Young, Range Scientist, USDA Agricultural Research Service, Reno, Nevada and Dan McKenzie Range Scientist and Mechanical Engineer, USDA Forest Service, Technology and Development Center, San Dimas, California

Beginning as early as the 1880's, heavy concentrations of cattle and horse grazing in certain areas of the west had noticeably affect range productivity. Perennial grass depletion allowed nonpreferred shrubs to increase causing various groups to investigate techniques for rehabilitating sagebrush rangelands.

By the mid-1940's, the Forest Service claimed a 90 percent successful pilot seeding program, but equipment breakage was still a major problem. Other land management agencies with similar problems eventually led to a committee for Range Seeding Equipment of federal interagency composition.

Among the first projects undertaken was evaluation of current brush control equipment. If sagebrush ranges were to be successfully reseeded, a workable mechanical means of control had to be developed. Extensive testing and refining resulted in the brushland plow. The plow increased the effectiveness of a seed drill by reducing competition from both new and old growth brush.

The development of a rangeland drill which resisted breakage and could be used anywhere a small crawler could be driven was the next goal. The original drill developed from an "idea-that-was-practical" stage through full-scale engineering and development. The prototype was not perfect, and over the years many modifications and attachments have been added.

The results of applied post-World War II technology in range improvement was startling in its results. Early spring is especially valuable to the livestock industry and is the period when native forage species are most susceptible to damage by excessive grazing. The successful seeding of wheatgrasses on degraded sagebrush ranges helped stabilize the livestock industry and added a new dimension to range management in the Intermountain West.

The Rangeland Drill

John R. Laird, President, Laird Welding and Manufacturing Works, Merced, California

Listed are the modifications and improved attachments for the Rangeland Drill from 1955-1981 as made by the Laird Company, one of the first commercial members to attend VREW meetings.

The cost of building the Laird Rangeland Drill has increased dramatically the last three to five years, with no significant increase in the price of the drill and its options. This will probably not be the case much longer, as the cost of component parts, product ability and labor are extremely high and continue to rise.

The Rangeland Drill is a low volume product, and the company has a large capital outlay for purchased components for two to three years in advance. This situation limits the amount it has been able to spend on experimentation.

Garrison Seed

Key Crawford, Garrison Seed & Company, Incorporated, Hereford, Texas

During the past couple of years, the seed industry has been under heavy pressure trying to furnish seed for the needs of the Conservation Reserve Program.

Grass seed prices have risen dramatically to new highs because of large demand and short supplies. These lucrative markets have given birth to any new small grass seed companies and independent suppliers.

At this time, the rush of CRP planting is over, and the demand has decreased to a point where the high prices of a year ago are showing some signs of erosion.

If prices decline to pre-CRP levels, it is not known how many of the newer grass seed companies and independent suppliers will remain in business. As the CRP demand decreases, it is anticipated that the additional planting will revert to other irrigated crops, but the company will maintain its original production which came from foundation seed.

History of Ag-Renewal

Weldon Miller, President, AG-Renewal, Incorporated, Weatherford, Oklahoma

AG-Renewal, Inc., provides goods and services to forage producers to help them better manage their forage businesses. The company markets plant materials and equipment that research facilities have developed.

Equipment handled by the company includes the Pneumatic-Seed Shucker, the Hi-Intensity Scalper Seed Cleaner with Fluidic Seed Classifier and the Woodward Flail-Vac Seed Stripper. The seed shucker is used as a tool to determine within several minutes if fields are worth harvesting, if seed offered is at claimed purity level and to monitor the cleanout.

The seed cleaner is air operated, providing a safety factor against dust explosion. Seed with low seedling vigor and poor germination is isolated and removed by the classifier.

The Flail-VAC is a rotary brush stripper which attaches to a tractor's front-end loader. The brush creates a vacuum, drawing in the seed head while stripping the ripe seed and depositing it in the hopper. Immature seeds are left for later harvesting.

AG-Renewal also markets five varieties of Old World Bluestem Grasses; Plains Bluestem, Ganada, Spar Bluestem, T-587 and Ironmaster. Miller believes that a higher percentage of land that is planted to these OWBs will stay in grass compared to land planted to other grasses, based on the excellent grazing results and wide acceptance of these grasses before CRP. The use of these plant materials has been significant and with profitable commercial application.

Arid Land Seeding

Harold T. Weidemann, Texas Agricultural Experiment Station, Vernon, Texas

A promising new device has been built to enhance grass establishment using the basin tillage (pitting) concept. The chain-diker was designed to conserve moisture and reduce runoff for dryland wheat; however, it appears well-suited for range seeding. Preliminary results have shown significantly better grass stands for the disk-chain-diker than disk-chaining or smoothing chaining alone.

The Unita Rangeland Drag was designed for small acreage sites where it is uneconomical to utilize heavy equipment. It is highly versatile, can be pulled by a standard pick-up and has been successfully used on sites such as tarweed flats,

heavily dispersed recreation areas, abandoned drill pads, campgrounds, old building and corral sites, and sheep bedgrounds. An average seedbed preparation of two-to-three inches of topsoil is generally achieved after dragging and then crossed again with the drag to cover the seed.

Instructions and a materials list for constructing the inexpensive, one-man unit are included.

Prescribed Fire Ignition-Blowgun

Phil Range, USDI Bureau of Land Management, Boise Interagency Fire Center, Boise, Idaho

Three years ago, the BLM contracted with a company called Wildland Resource Management of Walnut Creek, California, to develop a new ignition device for use on prescribed fires. The contract was for a proof of concept. Their device is called a Blowgun and was tested with great success. The Blowgun is composed of a launcher, fin-stabilized projectile containing the ignition system, and a compressed air source. Projectile propulsion is obtained from a standard air compressor.

The lightweight launcher will send the projectile over 300 years. The launcher assembly consists of a pneumatic miniature cannon. The projectiles contain sawdust, wx and potassium permanganate. Ethylene glycol is added to the potassium permanganate. Ignition takes place in 20 to 40 seconds and ignites the entire projectile. It burns for less than 10 minutes and has a flame height less than 15 inches. Projectiles are non-explosive and non-toxic, and easy to transport. When the unit is fully developed, the BLM expects to reduce the number of employees required to light a burn, cut some costs and improve safety.

Rehabilitation Equipment Development In Southern Idaho

Mike Pellant, USDI Bureau of Land Management, Idaho State Office, Boise, Idaho

Recent equipment development and modifications needed to implement a "greenstripping" program (establish strips of fire resistant vegetation) and to improve shrub restoration practices after wildfires has been reported by Idaho BLM offices.

A disk-chain has been used to prepare seedbed and plant perennial vegetation in cheatgrass dominated rangelands. Several modifications have been made to this original unit to correct deficiencies an to improve effectiveness.

The link-to-disk ratio has been increased to one-to-one with the addition of a disk to each chain. Complete soil turnover is now achieved, improving control of annual species. Wider V-shaped plates have been welded to the roller bar below the seed boxes to increase the area where seedbed connection occurs. Corrugated seed tubes have been replaced with smooth seed tubes to reduce seed tube clogging. A "windscreen" has also been installed behind seedboxes to stop seed from blowing behind the roller bars.

A sagebrush seeder has been constructed to reseed big sagebrush over large acreages. The seeder consists of three components, a fertilizer spreader, drag chains and a vine roller cultipacker. The Jarbridge Sagebrush Seeder can be pulled by a two-wheel drive tractor. Acceptable sagebrush establishment was obtained on two projects seeded with the unit in the fall of 1987.

The Boise district also has constructed a chain-harrow to solve the problem of damage that occurs to conventional models in areas with rock outcrops. It can be pulled with a two-wheel drive tractor at operating speeds of two to six miles per hour, depending on the amount of rock in the area. The chain-harrow should have the greatest application on coarse soils or when light seed coverage is required.

A Variable Stroke Mechanism For Mechanical Water-Pumping Windmills

F.Z. Kamand and R.N. Clark, Agricultural Engineers, USDA Agricultural Research Service, Conservation and Production Research Laboratory, Bushland, Texas

Research at the USDA Conservation and Production Research Laboratory, Bushland, Texas, indicates that when a standard windmill is equipped with a variable stroke mechanism the water pumped could be doubled. Positive displacement pumps which are used with mechanical windmills have a fixed stroke length and require constant operating torque from the windmill rotor. The available torque f rom the windmill rotor increases with windspeed squared. When the available rotor torque exceeds that of the load, the windmill rotor overspeeds almost in proportion to windspeed, thus not taking full advantage of the extra power available at the high windspeeds.

To better take advantage of the cubic relationship between windspeed and available power in the wind, the pumping load should be varied with windspeed. This can be ac accomplished by either varying the stroke length of the piston pump or by varying the gear ratio between the rotor and the pump. The most promising and practical approach to increase the pump discharge is to vary the stroke length of the pump in proportion to windspeed squared, thus improving the wind to water pumped conversion efficiency.

Independent Wind Electric Water Pumping

R. Nolan Clark, Agricultural Engineer, USDA Agricultural Research Service, Conservation and Production Research Laboratory Bushland, Texas; and William E. Pinkerton and Joe W. McCarty, Alternative Energy Institute, West Texas State University, Canyon, Texas

An independent wind electric system to provide the energy for pumping water offers several advantages over mechanical wind systems and solar systems. The wind turbine does not have to be located directly over the water source, thus allowing the selection of the best site for both the water supply and wind generator. Standard electric motors and pumps can be used with the electrical generating wind turbine.

Experiments have been conducted by the USDA, Agricultural Research Service and the West Texas State University, Alternative Energy Institute to evaluate the performance of independent wind pumping systems. A wind turbine with a permanent-magnet alternator was used to power standard three-phase induction motors connected to water pumps. Three pumping conditions were examined during the experiments: a low head, high volume pump; a high head, low volume pump and a medium head, medium flow pump were all tested at various capacities.

The use of a variable-frequency, variable voltage system expanded the useful operating range of the wind turbine and provided more water than mechanical systems.

Preventing Livestock Water From Freezing By The Use Of Insulated Watering Tanks

Dan W. McKenzie, Range Scientist and Mechanical Engineer, USDA Forest Service, Technology and Development Center, San Dimas, California

The Technology and Development Center has become aware of a commercial insulated livestock watering tank that appears to reduce the freezing of livestock water at low temperatures. The manufacture of the tank is:

Miraco
P.O. Box 686
Grinnell, Iowa 50112
(515) 236-5822 or (800) 541-7866

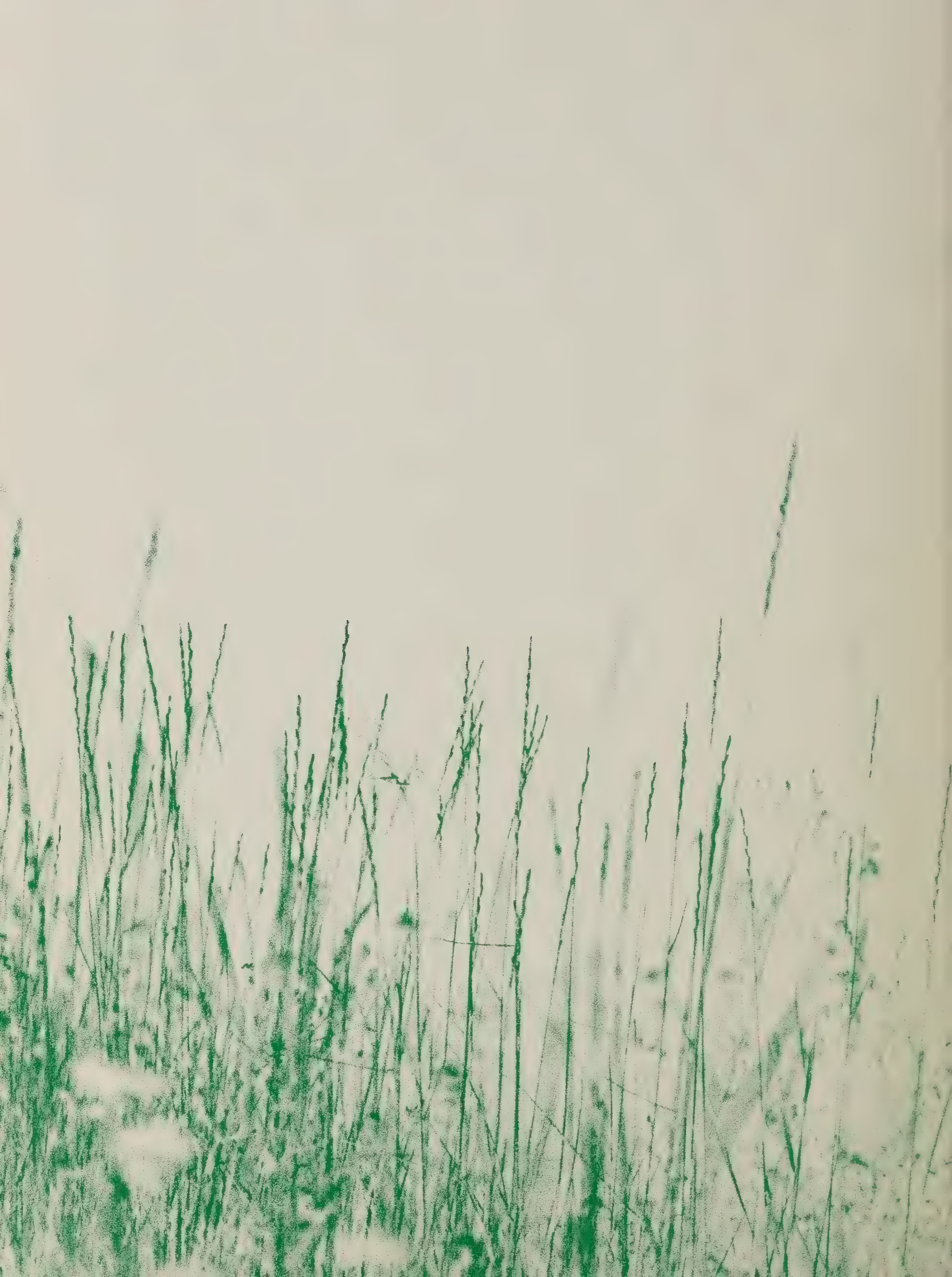
The watering tank is supplied in two configurations and in a number of sizes. The two configurations are a large ball float opening and a lift-up design. primarily for use with hogs, sheep and small cattle. Ten sizes are available ranging from 6 to 100 gallons. The test report from the US Bureau of Standards states that the Miraco insulated tank will work as stated anywhere in the Continental United States with as few as six head of cattle drinking every other day.

Attendance at Annual Meetings

Meeting			Participants				
Date	*Place*	Presiding Chairman	*Federal Gov't*	*State Gov't*	*Private*	*Foreign*	*Total*
Dec 1946	Portland[1]	Joseph F. Pechanec	6	0	0	0	6
Dec 1947	Ogden[1]	" "	9	0	0	0	9
Jan 1949	Denver	" "	15	0	0	0	15
Dec 1949	Ogden[1]	" "	22	0	0	0	22
Jan 1951	Billings	" "	34	5	0	0	39
Jan 1952	Boise	A.C. Hull	45	9	0	0	54
Jan 1953	Albuquerque	" "	75	15	9	1	100
Jan 1954	Omaha	" "	63	8	3	5	79
Jan 1955	San Jose	W.W.Dresskell	62	10	4	1	77
Jan 1956	Denver	William D. Hurst	86	12	1	2	101
Jan 1957	Great Falls	" "	95	10	4	0	109
Jan 1958	Phoenix	Frank C. Curtis	87	9	3	0	99
Jan 1959	Tulsa	" "	84	5	2	0	91
Jan 1960	Portland	" "	98	10	3	3	114
Jan 1961	Salt Lake City	" "	123	11	14	2	150
Jan 1962	Corpus Christi	Frank Smith	58	5	7	1	71
Jan 1963	Rapid City	" "	52	6	1	0	59
Jan 1964	Wichita	John Forsman	61	10	5	0	76
Jan 1965	Las Vegas	" "	77	8	6	0	91
Feb 1966	New Orleans	" "	47	8	5	1	61
Feb 1967	Seattle	A.B. Evanko	58	10	4	0	72
Feb 1968	Albuquerque	" "	84	16	13	1	114
Feb 1969	Great Falls[1]	" "	46	3	13	0	61
Feb 1970	Denver	" "	81	8	11	0	100
Feb 1971	Reno	" "	74	6	15	2	97
Feb 1972	Wash., D.C.	" "	48	3	6	0	57
Feb 1973	Boise	" "	60	7	7	4	78
Feb 1974	Tucson	Bill F. Currier	61	12	10	14	97
Feb 1975	El Paso[1]	Stan Tixier	49	9	11	1	70
Feb 1976	Omaha	" "	50	17	12	0	79
Feb 1977	Portland	Vern L. Thompson	63	26	31	10	130
Feb 1978	San Antonio	" "	68	26	35	6	135
Feb 1979	Casper	Ted Russell	74	35	72	12	193
Feb 1980	San Diego	" "	97	44	88	21	250
Feb 1981	Tulsa	" "	56	35	111	16	218
Feb 1982	Denver[1]	" "	60	18	68	5	151
Feb 1983	Albuquerque	" "	119	82	96	9	306
Feb 1984	Rapid City	Randall R. Hall	95	22	49	7	173
Feb 1985	SaltLakeCity	" "	110	46	85	13	254
Feb 1986	Orlando	Gerald Henke	41	31	29	13	114
Feb 1987	Boise	" "	94	35	34	5	168
Feb 1988	Corpus Christi	" "	42	14	23	8	87
Feb 1988	Billings	" "	65	19	23	2	109
Feb 1989	Reno	" "	19	11	13	3	46

[1] Meeting not in conjunction with Society for Range Manaement metting.

Notes



United States
Department of
Agriculture

Forest Service

**Technology &
Development
Program**

2200–Range
December 1991
9222-2808-MTDC

Rangeland Technology Equipment Council

1991 Annual Report

Rangeland Technology Equipment Council

1991 Annual Report

Participants:

U.S. Department of Agriculture
U.S. Department of the Interior
State and County Agencies
Industry Representatives
Educational Institutions
Ranchers
Foreign Countries

December 1991

Published by:

USDA Forest Service
Technology & Development Center
Bldg. 1, Fort Missoula
Missoula, Montana 59801

Contents

Agenda

Washington, D.C.
Sunday, January 13, 1991

Introductory Remarks

Stephen B. Monsen, Chairman
Range Technology Equipment
Council

Information and Publications

Dick Hallman
USDA Forest Service
Missoula Technology and
Development Center

Reports

Fire Management

Blow Gun Development -
Carol Rice,
Wildland Resource Management,
Walnut Creek, California.

Fire Effects Information System -
Bill Fischer,
USDA Forest Service,
Intermountain Fire Sciences Lab,
Missoula, Montana.

Aerial Ignition Technology and Expert Systems in Prescribed Fire -
Henry Wright,
Texas Tech University,
Lubbock, Texas.

Agriculture Aircraft in Firefighting -
Dennis Lamun, Aviation Specialist -
USDI-BLM, Boise, Idaho.

The Culture and Use of Native Plant Materials

Native Plant Issues -
Curtis Sharp,
National Plant Materials Specialist -
USDA-SCS, Washington, DC.

National Park Service Native Plant Needs -
Rocky Beaver, National Technical Advisor,
USDI-Park Service, Denver, Colorado.

SCS Plant Material Centers Role in Native Plant Development for National Parks -
Wendell Hassell,
Plant Materials Technical Advisor,
USDA- SCS, Denver, Colorado.

Developing Native Plants for Big Bend National Park -
James Alderson,
Plant Materials Specialist,
USDA-SCS, Temple, Texas.

Yellowstone National Park - Bridger Plant Materials Center Cooperative Native Plant Program -
Mark Majerus, Plant Specialist,
USDA-SCS, Bridger, Montana.

Use of Native Plants for Roadway Revegetation -
LeRoy Brady, Manager
Roadside Development Services,
Arizona Department of Transportation,
Phoenix, Arizona.

Establishment and Use of Native Plants in Road Revegetation -
Roy Smith and Dennis Markworth,
State Department of Highways and
Transportation, Austin, Texas.

Innovative Devices for Rangeland Seeding -
H.T. Wiedemann and B.T. Cross,
Texas Agricultural Experiment Station,
Vernon, Texas

Lunch

Workgroup Committee and Business Meeting

Drawings

Single copies of drawings are available from the Technology and Development Centers without charge.

Write to:

USDA Forest Service
Technology and Development Center
Building 1, Fort Missoula
Missoula, MT 59801

USDA Forest Service
Technology and Development Center
444 East Bonita Avenue
San Dimas, CA 91773

Drawings From MTDC

B.C. Drag Chain Scarifier, No. 790

Disk Chain Implement, No. 757

Optional Dryland Sodder Bucket, No. 682

Sprig Spreader, No. 652

Sprig Harvester, No. 651

Dryland Sodder, No. 631

Tubling Planter, No. 628

Basin Blade, No. 619

Horse Trap Trigger, No. 618

Mulch Spreader, No. 611

Tree Transport Container, No. 604

Tree Transplant Trailer, No. 6702

Modified Hodder Gouger, No. 583

Dixie Sager and Modified Ely Chain, No. 568

Drawings From SDTDC

Pipe Harrow, RM 1-01 and 02

Brushland Plow, RM 2-01 to 22

Oregon Press Seeder Assembly (not complete), RM 19-01 to 07

Plastic Pipe Layer Assembly, RM 21-01-03

Reel for Laying Plastic Pipe, RM 14-01

Contour Furrowers, RM 25-01-14

Rangeland Drill Deep Furrowing Arms, RM 26-46 to 61

Steep-Slope Seeder, RM 33-01-18

Demonstration Interseeder for Rocky and Brushy Areas, RM 35-01-09

Reports

Range Handbooks

***Richard G. Hallman*, Program Leader, USDA Forest Service, Missoula Technology and Development Center, Missoula, Montana**

Three range handbocks recently published by the Missoula Technology and Development Center are now available from the Society of Range Management in Denver. These structural improvement handbooks consolidate numerous handbooks now scattered through many federal agencies into three volumes: *Fences; Facilities for Handling, Sheltering, and Trailing Livestock; and Facilities for Watering Livestock and Wildlife.* Each volume describes components uses, advantages and disadvantages, safety and environmental concerns, suggestions for redesign or new concepts for future development. Costs are included where possible. Pertinent books and articles are included in a bibliography in each volume.

Facilities for Handling, Sheltering, and Trailing Livestock, 8724-2809, September 1987. This publication discusses facilities for wildland horse, sheep, and cattle management. The book describes corral systems (pens, alleyways, fences, and gates); restraining devices (loading, working, and squeeze chutes, cradles, and tables); and miscellaneaous facilities such as dipping vats, spray pens, dusting alleys, back rubbers, and scales. Sheltering facilities include sheds, shade shelters, windbrakes, and feeding and watering devices. The section on trailing livestock describes driveways and driftways, low-water crossings, culverts, corduroy log crossings, and bridges. Facilities discussed may apply to wildlife as well as domestic animals, but specific information on wildlife management is not included.

Fences (8824-2803, July 1988). This handbook consolidates information on planning, building, and maintaining fences. Information is included on: gathering site information; locating the fence; choosing a fence design; clearing the right-of-way; laying out the fence; and safety concerns. It describes components including braces and posts, brace designs, gates and materials and tools necessary to build a fence. Detailed descriptions of electric, wire, and wood fences are discussed.

Facilities for Watering Livestock and Wildlife, MTDC 89-1, January 1989. This volume gives an overview of basic concepts, techniques, and equipment used to provide water for livestock and wildlife. These facilities are improvements that collect, transport, store, or provide access to water. Collecting water discusses wells, pumps, windmills, dams, and reservoirs. Transporting water includes information on pumps and piping. Water storage describes reservoirs and storage tanks. The section dealing with access to water facilities describes methods of allowing wildlife and livestock to water without damaging the storage facility.

These volumes can be ordered from:

Society of Range Management
1839 York Street
Denver, Colorado 80206

There is a charge for each volume:

Fences, $10

Facilities for Watering Livestock and Wildlife, $6

Facilities for Handling, Sheltering and Trailing Livestock, $5

Workgroups

Steve Monsen, Chairman, RTEC
USDA Forest Service
Shrub Sciences Laboratory
735 N. 500 E.
Provo, UT 84664

Those interested in participating in the activities of a workgroup should write or call the workgroup chairman.

Information and Publications

Dick Hallman, Chairman, FS
Missoula Technology & Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801

Plant Materials

Wendall Oaks, Chairman, SCS
Plant Materials Center
1036 Miller St.
Los Lunas, NM 87031

Fire

Phil Range, Chairman, BLM
Boise Interagency Fire Center
3905 Vista Ave.
Boise, ID 83705

Seeding & Planting

Harold Wiedemann, Chairman
Texas Agricultural Experiment Station
Box 2658
Vernon, TX 76384

Seedbed Ecology

(Vacant)

Structures

(Vacant)

Weeds and Weed Management

(Vacant)

Introduction

The Vegetative Rehabilitation and Equipment Workshop was an informal group of range specialists who were concerned with developing and testing equipment and serving as a clearinghouse of information for land managers. The effort to adapt or develop equipment suitable for range seeding began in 1945. The original organization was called the Range Seedling Equipment Committee. In 1975 the group became the Vegetative Rehabilitation & Equipment Workshop (VREW) to better reflect the expanded interests and membership. The USDA Forest Service, the Bureau of Land Management, the Soil Conservation Service, the Bureau of Indian Affairs, as well as State agencies, universities, manufacturers, energy companies, seed suppliers, ranchers, and consultants met to consider harvesting brush and grass seed, evaluate aerial ignition techniques, develop equipment for reclaiming strip-mined land and revegetating disturbed areas in arid climates. The goal of establishing permanent, diverse vegetative cover remained the prime concern of VREW through 1989.

In 1990 the growing role of State and Private resource agencies led to a broader charter for the group. The Rangeland Technology and Equipment Council (RTEC) has been formed to incorporate all federal, state, and private range land managers. The Council will focus on high technology techniques as well as traditional equipment development for solving management problems.

This year's RTEC annual report presents a selection of equipment and techniques reported at the Washington, D.C. meeting by 1991 speakers.

Papers

Fire Effects Information System

William C. Fischer, Research Forester and Team Leader, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Intermountain Fire Sciences Laboratory, Missoula, Montana

Description of the System

The Fire Effects Information System is a computerized knowledge management system that stores and retrieves state-of-the-knowledge, English-language textual information organzied in an encyclopedic fashion. The design and structure of the system are based on artificial intelligence (AI) concepts, methods, and techniques previously described by Fischer and Wright (1987). Although based on AI technology, the Fire Effects Information System is not an "expert system" but rather a knowledge processor of the document database type (Rauscher 1987, Fischer and Brown 1991). The system was developed and is being implemented by the Forest Service, U.S. Department of Agriculture, at the Intermountain Research Station's Fire Sciences Laboratory in Missoula, Montana. System software was developed in cooperation with the Computer Science Department of the University of Montana, Missoula.

System Components

The Fire Effects Information System consists of three components: the knowledge base, the query program, and the builder program. The knowledge base contains the fire effects and related biological and ecological information that is available to those who access the system. The query program allows access to the knowledge base but does not allow any changes. It is designed for resource managers and resource specialists who are not necessarily computer experts. On-screen prompts and menus guide the operator to the desired information. The builder program is used only by those who are adding to or editing the knowledge base. Because it is the object of the system, the knowledge base is described in more detail below.

The Knowledge Base

The fire effects knowledge base is designed to accept information in three major categories: plant species, ecosystems, and wildlife species. The ecosystem category includes three levels of classification: an ecosystem level, a cover type level, and a habitat type or plant community level. For each category and level, the knowledge base contains state-of-the-knowledge information as text for various predetermined topics for several subject areas. Topics by subject for the plant species category are listed in *table 1.* Fischer (1987), Fischer and Wright, (1987) and Bradley (1990) provide examples of information as it is presented by the system. At present, the knowledge base contains information for 294 plant species (77 trees, 120 shrubs, 68 graminoids, and 29 forbs), 8 wildlife species, and 10 sagebrush cover types. Distribution of plant species according to their occurrence among the 34 Forest and Range Environmental Study ecosystems described by Garrison and others (1977) is presented in *table 2.* The Bureau of Land Management (BLM), U.S. Department of the Interior (USDI), provided initial as well as strong continuing support for knowledge base development.

The present data base contains, consequently, many of the common plant species that occur in Great Basin and southwestern United States rangelands. Prairie and plains grassland species were added to the knowledge base when the National Park Service, also USDI, supported development of a data base for Wind Cave National Park, South Dakota. The initial emphasis on plant species rather than wildlife species reflects the expressed needs of the agencies supporting knowledge base development. This is a logical decision because most fire effects of concern to wildlife managers are secondary effects caused by fire-related changes in wildlife habitat. More emphasis on wildlife species is anticipated during the next several years.

Current Access to the System

The Fire Effects Information System presently resides on a Data General (DG) computer at the Intermountain Fire Sciences Laboratory in Missoula, Montana. A copy of the knowledge base and query also resides on a BLM DG computer at the Boise Interagency Fire Center, Boise, Idaho. BLM personnel access the system at Boise using an IBM-compatible personal computer (PC) with a 1200 band phone modem and terminal emulation/communications software that can emulate a DG 400 terminal. Forest Service personnel access the system at the Fire Sciences Laboratory via the service-wide DG electronic communications system. Other natural resource agencies and institutions may obtain permission to access the system in Missoula provided they have the appropriate PC, modem and DG emulation and communications software.

Operational Implementation

A national operational implementation of the Fire Effects Information System is progressing under the auspices of the National Wildfire Coordinating Group (NWCG). The NWCG consists of members from the Forest Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, Fish and Wildlife Service, and the National Association of State Foresters. The purpose of NWCG is to coordinate the development and implementation of products that improve the overall effectiveness of fire management in member agencies.

Two major tasks associated with a national implementation are to provide system access to all interested users and to expand the knowledge base to meet national needs for fire effects information. During the implementation period at least 400 plant species will be added to the system's knowledge base.

Additional information regarding the Fire Effects Information System can be obtained from the Forest Service System Manager, Dave Anderson, Boise Interagency Fire Center, 3905 Vista Avenue, Boise, Idaho 83705-0126 or from the author.

Publications Cited

Bradley, A.F. 1990. *The fire effects information system: a tool for shrub information management.* ***In***: Proceedings - Symposium on Cheatgrass Invasion, Shrub Die-off, and Other Aspects of Shrub Biology and Management, 1989 April 5-7; Las Vegas, NV. General Technical Report INT-276, Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, p. 263-281.

Fischer, W.C. 1987. *The fire effects information system.* **In:** Proceedings of the Symposium on Wildland Fire 2000, 1987 April 27-30; South Lake Tahoe, CA. General Technical Report PSW-101, Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, p. 128-135.

Fischer, W.C.; Brown, J.K. 1991. *A document database system for managing fire effects knowledge.* The Compiler. (In press).

Fischer, W.C.; Wright, A.H. 1987. *FIRESYS: Using artificial intelligence techniques to build a fire effects information system.* The Compiler. 5(5): 28-35.

Rauscher, H.M. 1987. *Increasing scientific productivity through better knowledge management.* AI Applications. 1(2): 21-31.

Table 1. – ***Information contained in the Fire Effects Information System knowledge base for plant species.***

Plant Species Category

- Species name
- Abbreviation
- Synonyms
- Plant code (SCS list of scientific plant names)
- Taxonomy
- Life form
- Federal legal status
- Other status
- Compiled by and date
- Last revised by and date
- Authorship and citation

Distribution & Occurrence

- General distribution
- Ecosystems
- States
- Administrative units
- BLM phsiographic regions
- Kuchler plant associations
- SAF cover types
- Habitat types and plant communities

Value & Use

- Wood products value
- Importance to livestock and wildlife
- Palatability
- Food value
- Cover value
- Value for rehabilitation of disturbed sites
- Other uses and values
- Management considerations

Botanical & Ecological Characteristics

- General botanical characteristics
- Raunkiaer life form
- Regeneration process
- Site characteristics
- Successional status
- Seasonal development

Fire Ecology

- Fire ecology or adaptations
- Lyon-Stickney fire survival strategy

Fire Effects

- Immediate fire effect on plant
- Discussion & qualirfication of fire effect
- Plant response to fire
- Discussion & qualification of plant response
- Fire management considerations

Fire Case Study

- Case study name
- Reference
- Season-severity class
- Study location
- Preburn vegetation
- Target species phenological state
- Site description
- Fire description
- Fire effects on target species
- Fire management implications

References

Table 2. – *Number of plant species and life forms by ecosystem in the Fire Effects I nformation System (as of 31 January 1991).*

Ecosystem	Trees	Shrubs	Graminoids	Forbs	Total
Forest & Woodland Ecosystems					
White-red-jack pine	9	8	3	5	**25**
Spruce-fir	8	11	1	6	**26**
Longleaf-slash pine	2	1	1	1	**5**
Loblolly-shortleaf pine	4	2	2	2	**10**
Oak-pine	5	3	2	1	**11**
Oak-hickory	17	18	19	7	**61**
Oak-gum-cypress	7	1	1	—	**9**
Elm-ash-cottonwood	18	20	29	3	**70**
Maple-beech-birch	10	8	2	4	**24**
Aspen-birch	12	7	4	3	**26**
Douglas-fir	41	50	35	14	**140**
Ponderosa pine	56	71	55	18	**200**
Western white pine	12	15	—	5	**32**
Fir-spruce	39	43	28	18	**128**
Hemlock-Sitka spruce	13	29	1	3	**46**
Larch	11	17	2	5	**35**
Lodgepole pine	31	36	15	10	**92**
Redwood	17	18	—	5	**40**
Western hardwoods	48	38	10	6	**102**
Shrubland Ecosystems					
Sagebrush	34	63	54	17	**168**
Desert shrub	20	55	37	8	**120**
Shinnery	4	6	3	1	**14**
Texas savanna	13	9	13	1	**36**
Southwestern shrubsteppe	11	9	9	2	**31**
Chaparral-mountain shrub	44	69	49	10	**172**
Pinyon-juniper	39	69	54	13	**175**
Grassland Ecosystems					
Mountain grasslands	17	39	48	16	**120**
Mountain meadows	1	6	—	4	**11**
Plains grasslands	25	34	51	11	**121**
Prairie	14	18	32	6	**70**
Desert grasslands	16	40	29	7	**92**
Wet grasslands	2	1	4	—	**7**
Annual Grasslands	1	—	3	—	**4**
Alpine Ecosystems					
Alpine	4	14	7	5	**30**

Appendix:

Plant species, cover types, and wildlife species presently represented in the Fire Effects Information System.

Tree Species

Abies concolor, white fir
Abies lasiocarpa, subalpine fir — In preparation
Acacia greggii, catclaw acacia
Acer circinatum, vine maple
Acer glabrum, Rocky Mountain maple
Acer grandidentatum, bigtrooth maple
Acer macrophyllum, bigleaf maple
Acer negundo, boxelder
Alnus incana ssp. tenuifolia (A. tenuifolia), thinleaf alder
Alnus rhombifolia, white alder
Alnus rubra, red alder
Alnus viridis ssp. sinuata, Sitka alder
Arbutus menziesii, Pacific madrone
Arbutus texana, Texas madrone
Betula occidentalis, western birch, water birch
Castanopsis chrysophylla, golden chinkapin
Celtis occidentalis, hackberry
Celtis reticulata, netleaf hackberry
Cercocarpus ledifolius, curlleaf mountain-mahogany
Cercocarpus montanus, true mountain-mahogany
Chamaecyparis lawsoniana, Port-Orford-cedar
Chilopsis linearis, desert willow
Cornus (stolonifera) sericea, red-oiser dogwood
Cowania mexicana var. stansburiana, Stansbury cliffrose
Fraxinus pennsylvanica, green ash
Juglans microcarpa, little walnut
Juniperus communis, common juniper
Juniperus deppeana, alligator juniper
Juniperus monosperma, oneseed juniper
Juniperus occidentalis, western juniper
Juniperus osteosperma, Utah juniper
Juniperus scopulorum, Rocky Mountain juniper
Larix occidentalis, western larch
Lithocarpus densiflora, tanoak
Pinus albicaulis, whitebark pine
Pinus aristata, Rocky Mountain bristlecone pine
Pinus balfouriana, foxtail pine
Pinus edulis, true pinyon
Pinus flexilis, limber pine
Pinus longaeva, Great Basin bristlecone pine
Pinus monophylla, singleleaf Pinyon
Pinus ponderosa var. scopulorum, interior (Black Hills) ponderosa pine
Populus angustifolia, narrowleaf cottonwood
Populus balsamifera, balsam poplar
Populus deltoides, eastern/plains cottonwood
Populus fremontii, Fremont cottonwood
Populus tremuloides, aspen
Populus trichocarpa, black cottonwood
Prosopis glandulosa var. glandulosa, honey mesquite
Prosopis glandulosa var. torreyana, western honey mesquite
Proscopis pubescens, screwbean mesquite
Prosopis velutina, velvet mesquite
Prunus americana, American plum
Prunus ilicifolia, hollyleaf cherry
Prunus pensylvanica, pin cherry
Prunus virginiana, chokecherry
Quercus chrysolepis, canyon live oak
Quercus gambelii, Gambel oak
Quercus havardii, sand shinnery oak — In preparation
Quercus marcrocarpa, bur oak
Quercus muehlenbergii, chinquapin oak — In preparation
Quercus turbinella, turbinella oak
Quercus wislizenii, interior live oak
Rhododendron macrophyllum, Pacific rhododendron
Rhus glabra, smooth sumac
Salix amygdaloides, peachleaf willow
Salix exigua, sandbar willow
Salix lasiandra, Pacific willow
Salix lutea (S. rigida var. watsonii), yellow willow
Salix scouleriana, Scouler willow
Sambucus cerulea, blue elderberry
Sambucus racemosa ssp. pubens, red or black elderberry
Sapindus saponaria var. drummondii, western soapberry
Sophora secundiflora, mescalbean sophora
Taxus brevifolia, Pacific yew
Ungnadia speciosa, Mexican buckeye
Vaccinium arboreum, tree sparkleberry
Yucca brevifolia, Joshua tree
Yucca elata, soaptree yucca
Yucca schidigera, Mohave yucca

Shrub Species

Acacia constricta, whitethorn acacia
Adenostoma fasciculatum, chamise
Agave lechuguilla, lechuguilla
Ambrosia (Franseria) deltoidea, triangle bursage
Ambrosia (Franseria) dumosa, white bursage
Amelanchier alnifolia, Saskatoon serviceberry
Amelanchier utahensis, Utah serviceberry
Amorpha canescens, leadplant
Arctostaphylos pungens, pointleaf manzanita
Arctostaphylos uva-ursi, bearberry, kinnikinnick — In preparation
Artemisia abrotanum, oldman wormwood
Artemisia arbuscula ssp. arbuscula, gray low sagebrush
Artemisia arbuscula ssp. thermopola, hotsprings sagebrush
Artemisia argilosa, coaltown sagebrush
Artemisia bigelovii, Bigelow sagebrush
Artemisia cana ssp. bolanderi, Bolander silver sagebrush
Artemisia cana ssp. cana, plains silver sagebrush
Artemisia cana ssp. viscidula, mountain silver sagebrush

Artemisia filifolia, sand sagebrush
Artemisia frigida, fringed sagebrush
Artemisia longiloba, alkali sagebrush
Artemisia nova, black sagebrush
Artemisia papposa, Owyhee sagebrush
Artemisia pedatifida, birdfoot sagebrush
Artemisia pygmaea, pygmy sagebrush
Artemisia rigida, stiff sagebrush
Artemisia spinescens, budsage
Artemisia tridentata ssp. tridentata, basin big sagebrush
Artemisia tridentata ssp. vaseyana, mountain big sagebrush
Artemisia tridentata ssp. wyomingensis, Wyoming big sagebrush
Artemisia tripartita ssp. rupicola, Wyoming threetip sagebrush
Artemisia tripartita ssp. tripartita, tall threetip sagebrush
Atriplex canescens, fourwing saltbush
Atriplex confertifolia, shadscale
Atriplex gardneri, saltsage
Betula glandulosa, bog birch
Ceanothus cuneatus, wedgeleaf ceanothus
Ceanothus greggii, desert ceanothus
Ceanothus integerrimus, deerbrush
Ceanothus leucodermis, chaparral whitethorn
Ceanothus sanguineus, redstem ceanothus
Ceanothus velutinus, snowbrush ceanothus
Ceratoides lanata, winterfat
Chrysothamnus nauseosus, rubber rabbitbrush
Chrysothamnus viscidiflorus, low rabbitbrush
Cornus canadensis, bunchberry
Coleogyne ramosissima, blackbrush
Ephedra nevadensis, Nevada ephedra
Ephedra viridis, green ephedra
Fallugia paradoxa, Apache plume
Flourensia cernua, tarbush
Gaultheria shallon, salal
Garrya wrightii, Wright silktassel
Grayia brandegei, spineless hopsage
Grayia spinosa, spiny hopsage
Gutierrezia sarothrae, broom snakeweed
Heteromeles arbutifolia, toyon
Holodiscus discolor, oceanspray
Holodiscus dumosus, bush oceanspray
Juniperus horizontalis, creeping juniper
Larrea tridentata, creosotebush
Leptodactylon pungens, prickly phlox
Mahonia (Berberis) nervosa, dwarf Oregon grape
Mahonia (Berberis) trifoliolata, agarito
Mimosa biuncifera, catclaw mimosa
Opuntia polyacantha, plains pricklypear
Philadelphus lewisii, mockorange
Potentilla fruticosa, shrubby cinquefoil
Prunus andersoni, desert peach
Purshia glandulosa, desert bitterbrush
Purshia tridentata, antelope bitterbrush
Quercus dumosa, scrub oak
Rhamnus californica, California coffeeberry
Rhus aromatica, fragrant sumac
Rhus microphylla, littleleaf sumac
Rhus trilobata, skunkbush sumac
Ribes americanum, American black currant
Ribes aureum, golden currant
Ribes cereum, wax currant
Ribes lacustre, swamp currant
Ribes montigenum, gooseberry currant
Ribes odoratum, buffalo currant
Ribes setosum, bristly gooseberry
Ribes velutinum, desert gooseberry
Rosa acicularis, prickly rose
Rubus discolor, Himalayan blackberry
Rubus idaeus, red raspberry
Rubus laciniatus, evergreen blackberry
Rubus parviflorus, thimbleberry
Rubus spectabilis, salmonberry
Rubus ursinus, trailing blackberry
Salix lemmonii, Lemmons willow
Salvia mellifera, black sage
Sarcobatus baileyi, Bailey greasewood
Sarcobatus vermiculatus, black greasewood
Symphoricarpos longiflorus, desert snowberry
Symphoricarpos oreophilus, mountain snowberry
Tetradymia canescens, gray horsebrush
Tetradymia glabrata, littleleaf horsebrush
Tetradymia nuttallii, Nuttall horsebrush
Tetradymia spinosa, spiny horsebrush
Toxicodendron rydbergii, western poison ivy
Toxicodendron diversilobium, poison oak
Vaccinium angustifolium, low sweet blueberry — In preparation
Vaccinium caespitosum, dwarf huckleberry
Vaccinium globulare, globe huckleberry
Vaccinium membranaceum, blue huckleberry
Vaccinium myrsinites, ground blueberry
Vaccinium myrtilloides, velvetleaf blueberry
Vaccinium myrtillus, dwarf bilberry
Vaccinium occidentale, western huckleberry
Vaccinium ovalifolium, ovalleaf huckleberry
Vaccinium ovatum, evergreen huckleberry
Vaccinium parvifolium, red huckleberry
Vaccinium scoparium, grouse whortleberry
Vaccinium vacillians, lowbush blueberry — In preparation
Vaccinium vitis-idaea, mountain cranberry — In preparation
Yucca baccata, banana yucca
Yucca glauca, soapweed yucca
Yucca whipplei ssp. caespitosa, Our Lord's candle
Yucca whipplei ssp intermedia, Our Lord's candle
Yucca whipplei ssp parishii, chaparral yucca
Yucca whipplei ssp. percursa, Our Lord's candle
Yucca whipplei ssp. whipplei, Our Lord's candle

Graminoid Species

Agropyron cristatum (A. pectiniforme), fairway wheatgrass
Agropyron desertorum, standard wheatgrass
Andropogon gerardii var. gerardii, big bluestem
Andropogon gerardii var. paucipilus (A. hallii), sand bluestem
Aristida purpurea (A. longiseta), red three-awn
Bothriochloa (Andropogon) barbinodis, cane bluestem
Bouteloua barbata var. barbata, six-weeks grama
Bouteloua curtipendula, sideoats grama
Bouteloua eriopoda, black grama
Bouteloua gracilis, blue grama
Bouteloua hirsuta, hairy grama
Bromus carinatus, California brome
Bromus inermis, smooth brome
Bromus japonicus, Japanese brome
Bromus marginatus, mountain brome
Bromus mollis, soft chess
Bromus rubens, red brome
Bromus tectorum, cheatgrass
Buchloe dactyloides, buffalograss
Calomovilfa longifolia, prairie sandreed
Carex heliophila, sun sedge
Danthonia intermedia, timber oatgrass
Danthonia spicata, poverty oatgrass
Danthonia unispicata, onespike danthonia
Distichlis spicata var. stricta, inland saltgrass
Elymus canadensis, Canada wildrye
Elymus elymoides, (Sitanion hystrix), bottlebrush squirreltail
Elymus glaucus, blue wildrye
Elymus lanceolatus, (Agropyron dasystachyum, A.elmeri, A. riparium), thickspike wheatgrass
Festuca idahoensis, Idaho fescue
Festuca scabrella, rough fescue
Festuca thurberi, Thurber fescue
Hilaria belangeri, curly mesquite
Hilaria jamesii, galleta
Hilaria mutica, tobosa
Hilaria rigida, big galleta
Koeleria cristata, prairie junegrass
Leucopoa kingii (Hesperchloa kingii), spike fescue
Leymus (Elymus) ambiguus, Colorado wildrye
Leymus (Elymus) cinereus, basin wildrye
Leymus (Elymus) innovatus, boreal wildrye
Leymus (Elymus) salinus, Salina wildrye
Muhlenbergia cuspidata, plains muhly, Stonyhills muhly
Muhlenbergia porteri, bush muhly
Muhlenbergia racemosa, green muhly
Muhlenbergia richardsonis, mat muhly
Oryzopsis hymenoides, Indian ricegrass
Pascopyrum (Agropyron) smithii, western wheatgrass
Poa arida, plains bluegrass
Poa cusickii, Cusick bluegrass
Poa fendleriana, Fendler bluegrass
Poa secunda, (P.ampla; P.canbyi; P. juncifolia; P.nevadensis; P.sandbergii), Sandberg bluegrass
Psathyrostachys juncea (Elymus junceus), Russian wildrye
Pseudoroegneria spicata (Agropyron spicatum; A.inerme), bluebunch wheatgrass
Schizachyrium (Andropogon) scoparium, little bluestem
Sporobolus airoides, alkali sacaton
Sporobolus asper, tall dropseed
Sporobolus cryptandrus, sand dropseed
Sporobolus flexuosus, mesa dropseed
Stipa columbiana, Columbia needlegrass
Stipa comata, needle-and-thread grass
Stipa lettermanii, Letterman needlegrass
Stipa thurberiana, Thurber needlegrass
Stipa viridula, green needlegrass
Taeniatherum caput-medusae, medusahead
Vulpia (Festuca) microstachys, small fescue
Vulpia myuros (Festuca megalura), foxtail fescue
Vulpia (Festuca) octoflora, sixweeks fescue

Forb Species

Achillea millefolium, western yarrow
Actaea rubra, red baneberry
Artemisa campestris, western sagebrush
Artemisia dracunculus, tarragon
Artemisia ludoviciana, Louisiana sagewort
Balsamorhiza hookeri, Hooker balsamroot
Balsamorhiza sagittata, arrowleaf balsamroot
Centaurea diffusa, diffuse knapweed
Centaurea maculosa, spotted knapweed
Centaurea solstitialis, yellow starthistle
Corydalis sempervirens, pink corydalis
Darlingtonia californica, California pitcher plant
Descurainia pinnata, pinnate tansymustard
Descurainia sophia, flixweed tansymustard
Erythronium grandiflorum, glacier lily
Goodyera repens, northern rattlesnake plantain
Hedysarum alpinum var. americanum, American sweetvetch
Lycopodium obscurum, ground pine
Polystichum munitum, swordfern
Potentilla glandulosa, sticky cinquefoil
Potentilla hippiana, horse cinquefoil
Potentilla newberryi, Newberry cinquefoil
Pteridium aquilium, bracken fern
Ranunculus glaberrimus, sagebrush buttercup
Selaginella densa, little cubmoss
Sisymbrium altissimum, tumblemustard
Sisymbrium linifolium, flaxleaf plainsmustard
Spaeralcea coccinea, scarlet globemallow
Xerophyllum tenax, beargrass

Cover Types

Artemisia arbuscula ssp. arbuscula C.T., gray low sagebrush cover type
Artemisia arbuscula ssp. thermopola C.T., hotsprings sagebrush cover type
Artemisia cana ssp. bolanderi C.T., bolanderi silver sagebrush cover type
Artemisia cana ssp. cana C.T., plains silver sagebrush cover type
Artemisia cana ssp. viscidula C.T., mountain silver sagebrush cover type
Artemisia filifolia C.T., sand sagebrush cover type
Artemisia frigida C.T., fringed sagebrush cover type
Artemisia nova C.T., black sagebrush cover type
Artemisia tridentata ssp. tridentata C.T., basin big sagebrush cover type
Artemisia tridentata ssp. wyomingensis C.T., Wyoming big sagebrush cover type

Wildlife Species

Amphibians & Reptiles

Ambystoma macrodactylum ssp. krausei, northern long-toes salamander
Crotalus viridis, western rattlesnake — In preparation
Sceloporus graciosus, sagebrush lizard — In preparation
Scophiopus intermontanus, Great Basin spadefoot toad

Birds

Aquila chrysaetos, golden eagle — In preparation
Athene cunicularia, burrowing owl
Buteo regalis, ferruginous hawk — In preparation
Centrocercus urophasianus, sage grouse
Falco mexicanus, prairie falcon — In preparation

Mammals

Antilocapra americana, pronghorn
Lepus californicus, black-tailed jackrabbit
Perognathus parvus, Great Basin pocket mouse
Spermophilus townsendii, Townsend's ground squirrel

Aerial Ignition Techology and Expert Systems

Henry A. Wright Texas Tech University, Lubbock, Texas

We burn 10,000 to 20,000 acres of chained redberry juniper (*Juniperus pinchoti*) each year. Redberry juniper is a sprouting species. Thus, our burns generally contain a mixture of grass, dead brush and green juniper trees that are 5 to 10 feet tall. In order for us to burn this much acreage in moderately rough country, we began using the helitorch method of burning in 1983.

Initially, our ignition system consisted of an 80 amp igniter in a 2-inch bell housing where jellied gasoline was pumped out. The jell fell in large globs about every 100 feet. Moreover, we emptied a barrel of jell in 5 to 10 minutes. For grassland-brush mixtures we needed a delivery system that would break up the jell into small ignited particles and be able to stay in the air for longer periods of time.

To accomplish our objective a stainless steel screen was welded to the original bell housing with a valve to control rate of flow. This screen area served as a wick to ignite five streams of jell from 3/16-inch orifices that were mounted with a separate control valve about 1-inch behind the stainless steel screen. To control pressure of jell flow, a backfeed was added to allow jell to flow back to the top of the barrel. Thus, less jell was wasted. This mechanism proved to be a very efficient ignition system and allowed us to remain airborn for 25 minutes per 55-gallon load.

Flying at 75 to 100 feet above the ground, our swath width is 40 to 45 feet. We call it a "rain-drop system" because of the raindrop pattern of ignited jell. We currently use this ignition system to burn 400-foot blacklines together with hand crews, depending on weather conditions. For headfires, we only use the helitorch because it is more effective than hand ignition (burns hotter) and allows us access to rough country. Generally we fly 100- to 200-yard strips, but fly along the base of hills when possible.

We mix 6 pounds of alumijel per 55-gallon drum of unleaded gas to make our jell. Four people are needed to load each barrel. We always use the front-load method because it is safer. Moreover, the pilot can see everyone and direct them as necessary. While igniting the brush, an observer is permitted to be with the pilot to direct him where to fly and help keep the fire within the lines prepared. The observer should be experienced in fire behavior as well as be knowledgeable about the unit to be burned (boundaries, power lines, oil tanks, etc.)

Chained redberry juniper is a highly volatile fuel type. Thus, weather and fuel data are taken every 30 minutes to avoid burning when spot fires may occur. Hand burning is used when conditions are marginal for burning blacklines (i.e., relative humidity 30-50%; air temperature 50 to 65 degrees F, wind 6 to 10 mph). Nighttime is safer than daytime (i.e., we would burn with relative humidity as low as 30% during nighttime, but in the daytime it must be at least 40%). The helicopter is used to burn blacklines when the relative humidity is above 50%, temperature is below 50 degrees F, and wind speed is less than 6 mph. Headfires are conducted only in the daytime when air temperature is 65 to 80 degrees F, relative humidity is 25 to 40%, and wind speed is 8 to 15 mph. Green juniper moisture content must be below 80%. Generally it is between 60% (very dry) and 80%.

We are developing an Expert System to burn volatile fuels. Using a laptop computer, we punch in air temperature, relative humidity, wind speed, green juniper fuel moisture content, day or nighttime, roughness of topography, and fuel load to advise "burning" or "no burning". A confidence level of risk and a narrative is given with each burning or no burning answer. In our judgement the Expert System is conservative (safe) and especially helpful to newly trained peole who are learning the art of prescribed burning.

Overall, we are very satisfied with the ignition system for jellied gasoline. This year, instead of the sling, we are building a fuel tank that will be tightened snug to the skids of the helicopter but still ejectable. Remote controls for flow valves of the jellied gasoline are essential because the flow rates need to be adjusted during flight depending on the wind direction. We generally fly 60 knots/hr with the wind and 40 knots/hr against the wind. We burn about 1400 acres/hour (two barrels of jellied gasoline) on headfires. Two to three miles of blackline can be burned per hour with the helitorch, whereas this is usally a 5 to 6-hour job with a 15-person hand crew.

Cost to burn blacklines has not been established. Cost for the helitorch to burn headfires is $1.25 per acre, provided that we have a minimum of 10,000 acres to burn.

Agricultural Aircraft in BLM Fire Suppression

Ron Hanks, Aviation Specialist, USDI Bureau of Land Management, Boise, Idaho

Since the early 1950's the evolution of aerial retardant aircraft in the federal firefighting inventory has evolved toward increasingly larger multi-engine aircraft. As a result today's fleet of large air tankers requires long paved runways, large loading ramps, wide aprons, and taxiways capable of supporting tremendous wheel weights. This situation created a void in the air attack system because airports meeting these requirements were often long distances from the fire line. Heretofore, we have attempted to fill this void with helicopters using a variety of fixed tanks and sling mounted buckets. While helicopter operations have been successful they are expensive and require considerable amounts of government support equipment and personnel.

In 1984, the Bureau of Land Management formally began to evaluate the use of commercial agricultural application aircraft "crop-dusters" in the fire suppression program. It was hoped these aircrat could be used to fill the void at significantly less cost. This has proven to be the case.

Over the past thirty years considerable advancements have occurred in agricultural aircraft. Along with improved airframe design and construction, modern agricultural application aircraft use turbine engines, and improved tanking and gating systems. Agricultural aircraft can operate from the most rudimentary airports and often operate from non-airport sites. Agricultural aircraft operators are equipped and accustomed to handling toxic and caustic chemicals such as herbicides and insecticides. As a result they have the ground mixing and loading equipment and personnel eminently qualified to support the aerial delivery of firefighting chemicals. The small size and good maneuverability of the aircraft coupled with reliable powerplants enable many models to deliver an average of 400 (U.S.) gallons of fire retardant into "tight" spots with minimal need for any government support personnel or equipment.

In summary, BLM has found that substantial aerial fire fighting capability is presently available from agricultural aircraft operators. The services of these vendors are readily available to serve most of our users. They can be used and managed effectively by local fire managers, and are very cost effective.

The Native Plant Issue

W. Curtis Sharp, National Plant Materials Specialist, USDA Soil Conservation Service, Washington, DC

There are no doubt, many native plant issues. This paper will address only one. First, however, a definition of native plants needs to be established. The definition I will use is: "A plant that evolved within an identifiable ecological zone", such as those proposed by James M. Omernik, in Ecoregions of the U.S., H. L. Shantz, Natural Vegetation or A.W. Kuchler in Potential Natural Vegetation or others. It is presented here only as a point of reference for my comments. As my remarks continue, you will see the need to define 'ecological zones' also.

The issue I would like to discuss is: Availability of native plants to meet re-vegetation needs.The following comments relative to the availability of native plants is based on the assumption that the use of native plants for re-vegetating alterations to plant communities is highly desirable on both public or private lands, and is likely to increase. Such sites include construction sites, government supported conservation plantings, degraded rangeland, plantings to re-establish plant diversity, wildlife habitat improvement plantings and re-vegetation following fires.

Regardless of the desirability of using native plants for re-vegetation purposes, their use will be no greater than their availability. The demand for native plants generally falls into two categories:

A. Large scale demands, such as rangeland re-vegetation, government supported conservation plantings, or plantings following major fires. Such plantings would normally exceed 10 acres and may be several hundred acres.

   These needs are generally being met, or should be met by commercial production of cultivars of natives, developed by the Soil Conservation Service or others. This material will be characterized by broadly based ecotypes and adptable over many ecological zones. The number of ecotypes and/or species available at any one time on the commercial market will be small, however.

B. The demand for native plants to re-vegetate what I will call 'micro-sites'. Micro-sites might consist of less than one or up to a few acres.

   The demand for plant materials for these sites is characterized by:

   1) the desire of the land owner or manager to duplicate as nearly as possible the native vegetation;
   2) the potential of thousands of micro-sites collectively requiring a very large number of ecotypes for re-vegetation purposes, and
   3) the cost of having ecotypes available on a micro-site by micro-site basis is very high relative to the cost of commercially available plant materials. There is, nevertheless, a need for a cost effective and continuously available supply of a large number of native ecotypes for re-vegetating micro-sites.

How can this be done? The following is offered as one approach.

Public and private groups with an interest and/or responsibility for maintaining native plant diversity on public and private lands, and for technology development, to:

1. Agree on a set of ecological zones,

2. Identify and collect ecotypes within ecological zones that are representative of a selected set of species,

3. Develop the technology for propagating these species,

4. Produce small quantities,

5. Deposit this material into a bank of 'ecological zone ecotypes', and maintain,

6. Make small amounts from the bank available to public and private groups for increasing the ecotype to meet the immediate need, logically by a commercial firm, or for actually making micro-site plantings, if the quantity needed is very small. At the time a withdrawal is made arrangements to re-deposit that which was removed from the bank would need to be made.

The bank would be owned and managed by involved agencies and private groups, sharing the cost. Plants in the bank would not logically be maintained in the commercial trade, unless an ecotype showed unusual adaptation to many ecological zones.

The six steps above may seem like a very large task. However, many of the pieces to make it a reality exist today. The major task will be to bring them together in a cooperative spirit and coordinate them into a functioning system. The Soil Conservation Service has many of the required resources and facilities in place within their Plant Materials Center Program and are willing to assist in the coordination.

National Park Service Native Plant Needs

William R. Beavers, National Technical Advisor for Plant Materials, USDI National Park Service, Denver, Colorado

The National Park System of the United States comprises 356 areas covering almost 80 million acres in 49 states, the District of Columbia, America Samoa, Guam, Puerto Rico, Saipan, and the Virgin Islands. These areas are of such national significance as to be afforded protection by various acts of Congress.

After the establishment orf Yellowstone National Park on March 18, 1872, a worldwide park movement began that has resulted in more than 100 nations setting aside 1,200 national parks for public enjoyment and the preservation of natural, cultural, or historical resources.

The diversity of the National Park system is reflected in the variety of the park unit titles. Congress has used more than 20 different designations in adding areas to the National Park System. These titles are usually descriptive: seashore, lakeshore, historic site, battlefield, and recreation area, for example. The designations have not always been used consistently, but they reflect certain precedents that have been followed by Congress. The title of national park has traditionally been reserved for the most spectacular natural areas with a wide variety of features. All these areas are managed by the National Park Service in accordance with specific legislative mandates set forth by Congress. Key management requirements for all park units are that they must provide for public use in such a way that will leave their resources "unimpaired for the enjoyment of future generations."

Achieving this management objective of preserving resources while providing for public enjoyment is a delicate balancing act for the park administrator. Revegetation and reclamation activites present special problems when trying to maintain native plant populations in areas impacted by visitor facilities. When preserving natural resources National Park Service policy seeks to perpetuate native plant life as part of the natural ecosystems. To the extent possible, plantings in park units consist of species that are native to the park or that are historically appropriate for the event commemorated. To this end a cooperative agreement between the National Park Service and the Soil Conservation Service was developed in 1989. This cooperative Plant Materials Program seeks to draw upon the strengths of the two federal agencies in the development, testing, and establishment of native species for disturbed sites within National Park Service units.

The plant materials program between the two agencies initially focused on development of native plants for the revegetation of areas disturbed by road construction. Reconstruction of park roads is handled through monies allocated to the National Park Service from the Federal Highway Administration and is obtained from the National Highway Trust Fund. The National Park Service receives over 60 million dollars annually which is allocated to construction or repair of approximately 200 miles of road out of the 4800 miles of paved roads contained within the park system. The park roads program between the National Park Service and the Federal Highway Administration is the ideal starting point for the plant material program. Since advanced scheduling and funding appropriations are critical to the timely success of this program, the park roads program assures that all plant materials projects will be adequately funded and that sufficient lead time will be available to complete plant production schedules.

Presently, the National Park Service and the Soil Conservation Service have developed plant materials agreements for 20 park road projects with an annual budget exceeding half a million dollars. In addition, a park wide plant materials program is under development within the Rocky Mountain Region of the National Park Service and should be extended to most parks within the next four years. Within the next five years the plant materials program can be expected to grow to an annual budget exceeding 1.5 million dollars that will address plant materials needs in 40 park units. Native plant needs will range from cool to warm season grasses, to a variety of shrubs and half shrubs, to trees ranging from the Pacific Northwest to the forests of the deep south. The majority of these plants will not be available to the National Park Service through commercial suppliers. Basic information about the development and growth habits of these plants is presently lacking. The plant program and information generated over the coming years will add to the information base and will help develop park indigenous species that are locally adaptive. In addition, this program will provide the needed reclamation technologies to develop successful revegetation techniques in reestablishing these native park species. The National Park Service feels that its association with the Soil Conservation Service will be most helpful in the understanding and development of native plants.

Soil Conservation Service Plant Materials Role in Developing Native Plants for Parks

Wendell G. Hassel, Plant Materials Technical Advisor to the National Park Service, USDA Soil Conservation Service, Denver, Colorado

The National Park Service (NPS) plant materials needs for native species and establishment methods complement on-going revegetation programs at several Soil Conservation Service (SCS) Plant Materials Centers (PMC). The agencies felt a cooperative effort could:

1. Promote better resource management and protection.
2. Improve public service.
3. Accelerate the development of needed native plants.
4. Advance the state-of-the-art for reclamation and revegetation.

The SCS has been providing plant materials and technical assistance to land managers over the past fifty years. Specialized vegetation and techniques required are not always available. The SCS established 26 PMCs throughout the United States to develop plants and technology to meet these needs.

Networking together centers accomplish national and local objectives. They are ecologicaly located to provide service to a given region. Each center has facilities and specialized equipment to handle a variety of native seed and plants operations needed in plant propagation and testing. The centers cooperate and utilize expertise developed by Agricultural Research Service, Forest Service, State Experiment Stations, and other research institutions. The SCS Plant Materials program is also unique in working relation with seed growers and the commercial seed industry across the United States.

Prior to March 14, 1989, when SCS and NPS formally signed a memorandum of understanding, four centers were conducting plant materials work with specific parks. In 1986, Yellowstone National Park had a four year agreement with the Bridger, Montana PMC, to collect, test, and develop plant materials for various road reclamation projects and the Bridger PMC was also working with Glacier National Park in 1987 to develope plant materials.

Corvallis Oregon PMC started working with Olympic in 1987 and the Meeker and Lockeford centers initiated long term agreements with Grand Teton and Yosemite National Parks respectively in 1988.

To date the cooperative plant materials projects have focused on road related revegetation work. Fifteen agreements have been developed under the new pilot program. However, most of these projects represent relatively small acreages. They vary in size from 10 to 120 acres. However, the technology and plant materials can be applied to adjacent areas.

Nine new cooperative agreements were completed in fiscal year 1990. These agreements include working with a total of 140 new indigenous plant species at seven PMC's shown below:

Plant Materials Agreements Established - FY '90

Park	SCS Plant Center	Years	No. Species
Bryce Canyon, UT	Meeker, CO	1990-96	9
Chickasaw, OK	Knox City, TX	1990-9	10
Cumberland Gap, KY	Beltsville, MD	1990-95	34
Grand Canyuon, AZ	Los Lunas, NM	1990-94	15
Great Smoky Mtns., TN	Quicksand, KY	1990-94	18
Mesa Verde, CO	Meeker, CO	1990-95	17
Mount Rainier, WA	Corvallis, OR	1990-95	14
Natchez Trace, MS	Coffeeville, MS	1990-94	15
Wupatki, AZ	Los Lunas, NM	1990-93	6

Eight new plant materials agreements are scheduled to be established in fiscal year 1991 as shown below:

Plant Materials Agreements scheduled - FY '91

Park	SCS Plant Center
Agate Fossil Beds, NE	Manhattan, KS
Assateague Island, MD	Cape May, NJ
Cumberland Gap, KY	Beltsville, MD
Gateway, NY	Cape May, NJ
Grand Teton, WY	Meeker, CO
Lake Mead, NV	Tucson, AZ
Lake Meredith, TX	Knox City, TX
Mount Rainier, WA	Corvallis, OR

The NPS Plant Materials program can generally be grouped into four main activities:

1. Seeds are collected within the parks to preserve the unique characteristics of the original plant genetic diversity.

2. Seed and plants are grown and reproduced at centers located with similar climatic conditions.

3. New technology is often needed to reproduce and grow these plants. New techniques are also tested to successfully establish and use the new species.

4. And finally quality seed of native germplasm along with the needed technology for establishment are returned to the park for use by resource managers.

In most parks, it is extremely important that native plant materials appropriate to an area be used for restoration work. If possible, it is desireable to restore the vegetation that was previously present before disturbance. Where disturbance is severe, restoration may have to begin at a lower successional stage and pioneer species considered.

Some of the options park managers use to revegetate a site with native species are:

1. Topsoiling - grade back a thin layer of topsoil with seed and duff; then respread over distrubed area after construction is completed.

2. Collection on site - collect the seed and/or plants on or near the site to be disturbed; then replant on site.

3. Reproduction of indigenous plants - collect seed of park indigenous plants and reproduce plants or seeds. The seed, on generation from original stock, is returned to the park for revegetation purposes.

It is proposed by some that preservation of genetic integrity (genetic resources) is the preservation of not only the full range of genotypes but also the natural proportions of and the natural interactions between genotypes. The interpretation and practical application of this policy could be very difficult within some plant communities. The MPS has several task force committees working on how this policy will apply.

Method of pollination, seed dispersal and plant longevity effect the common gene pool of a species. In working with parks, general guidelines are suggested for seed collection where specific species information is not available:

1. Collect ecotypes having approximately the same flowering time,

2. Collect where site conditions are similar and ecotypes are not isolated by geographic or vegetative features.

3. Collect ecotypes within less than 600 to 1200 feet elevational range.

There are several positive spin-offs from this program. Some of the materials being tested will have application to areas outside of park lands and new technology is being developed. For example, we are working with several other research agencies on long term seed storage of flowering dogwood (Cornus florida) for preservation from Anthracnose fungal disease; developing plant propagation methods for greenleaf manzanita (Arctostaphylos patula), and seed production cultural practices for grassleaf goldenaster (Corylposis major). However, one of the biggest benefits is the interchange of new ideas and technology between agencies.

Developing Native Plants for Big Bend National Park

James Alderson, Plant Materials Specialist, Soil Conservation Service, Temple, Texas

You have heard Curtis, Rocky and Wendell explain the needs, thoughts and concerns that convinced the Soil Conservation Service (SCS) and the National Park Service (NPS) to nationally recognize, support and encourage individual national parks and Plant Materials Centers (PMCs) to work together and realize some common objectives.

From the agenda, it is obvious that others besides the NPS need native plant materials and I am sure there are some stories to tell about cooperation between agencies in those efforts as well.

You have just heard the what and why of the overall NPS/SCS cooperative effort, and now I will tell you some of the when, where and how of a local agreement entered into under the national agreements. Mark will tell you of another.

In February of 1989, personnel from the James E. "Bud" Smith PMC at Knox City, Texas, and the NPS Denver Service Center met at Big Bend National Park (BBNP) to learn of the park's plans for road renovations and associated vegetative needs for erosion control and stabilization of road shoulders. Texas Parks and Wildlife Department was present as well because of similar needs on an adjacent state park.

We spent a day driving the roads scheduled for resurfacing. Along the way, it was obvious there are four distinct vegetative zones within the park. Species of plants vary from zone to zone because of the different soils, elevations, slope, exposures and rainfall but there are a few species common to all four zones. Part of the objective as we toured was to locate adequate colonies of specific species to make harvesting of seed effective and efficient.

The plan that evolved from this strategy session called for PMC personnel to collect seed of 8 species of grasses and forbs which would be taken to the PMC and planted in seed increase fields in 1989, 1990 and 1991. We reasoned that it might take 3 years to collect enough seed to plant large enough seed production fields for the volume of seed needed to treat 22 miles of road shoulders. Six species were selected as the basic components of a mixture suitable to the entire road section. The species are alkali sacaton (*Sporobolus airoides*), sideoats grama (*Bouteloua curtipendula*), cane bluestem (*Bothriochloa barbinodis*), green sprangletop (*Leptochloa dubia*), chisos bluebonnet (*Lupinus havardii*), and showy menodora (*Menodora longiflora*). Because of their unique ability to grow on steep, rocky slopes, we also agreed to collect seed of false grama (*Cathestecum erectum*) and chino grama (*Bouteloua breviseta*) but no promises were made of our ability to successfully germinate, establish and produce seed of these two.

Lynn Pace, Texas Parks and Wildlife Department employee, stationed at the Knox City PMC, and I returned to the park in October, 1989, and hand-collected seeds of the selected species. Since the summer of 1989 did not produce any general rains over the park, areas of seed production were few. There were no bluebonnets that year and showy menodora was not in seed production mode.

We collected enough sideoats grama, cane bluestem and chino grama seed to plant them and half of the alkali sacaton directly into increase fields at the PMC. These fields are furrow irrigated with rows 182 feet long, spaced 40 inches apart. There were 26 rows of sideoats, 10 rows of cane bluestem, and 2 rows each of chino grama and alkaki sacaton established successfully. We collected so little green sprangletop and false grama we felt we needed to start them in the greenhouse and establish production blocks vegetatively. These efforts successfully established 2 additional rows of alkali sacaton and one half row of green sprangletop. From 2 rows of chino grama and one half row of false grama planted vegetatively, only 12 plants of chino survived. The false grama was a total failure.

Alkali sacaton, sideoats grama, cane bluestem and green sprangletop all produced seed in the fall of 1990. The seed was harvested and is being cleaned for planting this May. It is expected enough will be available to increase the size of the production blocks to about 1 acre each of sideoats gramma, cane bluestem and alkali sacaton. The green sprangletop can be expanded to a little over one half acre.

Lynn Pace and Ray Cragar, assistant manager at Knox City PMC, returned to the park in November, 1990 and collected additional sideoats grama, green sprangletop and alkali sacaton. They were also able to get showy menodora. One additional forb not on the list was collected to find out if propagation techniques can be developed. If so, that plant, limoncillo (*Pectis angustifolia var. tenella*) will be produced also. Only one species, chisos bluebonnet, remains to be collected. It is an annual that germinates in the fall and makes seed in May or June. One more attempt will be made late this spring to find seed.

The agreement between BBNP and Knox City PMC specifies seed be delivered between fall 1991 and spring 1993. It looiks like we will be successful in meeting our obligations. If you visit the park after the fall of 1992, you will see the results on the shoulders of Ross Maxwell Scenic Drive.

Use of Native Plants for Roadside Revegetation

E. LeRoy Brady, Roadside Development Services Manager Arizona Department of Transportation, Highways Division, Phoenix, Arizona

The Arizona Department of Transportation Highways Division follows the policy of minimizing erosion and sediment damage to the highway and adjacent properties. The practices of erosion control during construction and maintenance bring the department into compliance with State and Federal laws and rules for erosion and sediment control. Just as important as compliance to the law is, the spirit with which erosion control by revegetation is carried out has a major effect. It is that spirit that convinces engineers and other highway design professionals of the environmental advantages and not to be ignored economic benefits of filling the ecological nitches created by construction and maintenance with native and appropriate introduced plants.

Roadside slopes are usually determined by engineering-geotechnical criteria established to minimize disturbance and material movement, right of way required and safety requirements. Consequently, we are usually working with steep slopes, soils of low fertility and even bio-toxic conditions. The limiting factors are compounded by low rainfall and limited rainfall effectiveness due to the slopes and compacted soils that are associated with highway construction.

We have learned to counteract these conditions by using amendments to improve the condition of the soil, plate toxic soil areas, flatten or bench slopes and rip and till compacted soils to enhance the potential for successful revegetation. Revegetation in desert areas — there is enough chance left to Mother Nature. Adequate implementation of preparation requirements is an absolute must for success.

Most highway projects provide an opportunity to determine what the soil problems will be or what toxic conditions must be dealt with during construction. In Arizona many of the soils are high in salts and frequently the offender is sodium. Environmentally sensitive areas and projects in urban areas are given special consideration. An example is a 110 acre traffic interchange area west of Phoenix which 3 years after construction was completely barren because of high salts, with sodium as high as 39%. The treatment was a combination of 8,000 pounds of gypsum and 400 pounds of sulphur per acre, tilled in and then plated with 6 inches of soil which was seeded, mulched and today supports native vegetation. This native vegetation controls erosion and visually blends the right of way with the surrounding area.

Selection of seed mixes must be related to the soil, rainfall patterns and seasonal characteristics which in Arizona are most closely tied to elevation.

A seed mixture that would be used in the Tucson and Phoenix Areas —

A low elevation seed moisture. Below 4500 ft.

Seed Species	Rate per Acre
Cochise lovegrass (*Eragrostis Trichopora*)	1#
Lehmann lovegrass (*Eragrostis lehmanniana*)	1#
Mediterraneangrass (*Schismus barbatus*)	2#
California poppy (*Eschscholtzia Californica*)	3#

A seed mixture that would be used in the Prescott and Payson areas —

A medium elevation seed mixture. 4500-6500 ft.

Seed Species	Rate per Acre
Blue grama (*Bouteloua gracilis HACHITA*)	1#
Crested Wheatgrass (*Agropyron desertorum Nordum*)	3#
Sideoats grama (*Bouteloua curtipendula Vaughn*)	3#
California poppy (*Eschscholtzia Californica*)	3#
Indian blanket (*Gaillardia puchella*)	1#
Streambanks wheatgrass (*Agropyron riparium Sodar*)	3#
Cicer milkvetch (*Astragalus cicer*)	2#

A seed mixture that would be used in the Flagstaff and Williams areas —

A high elevation seed mixture. 6500-7500 ft.

Seed Species	Rate per Acre
Pubescent wheatgrass (*Agropyron trichophorum Lune*)	3#
Western wheatgrass (*Agropyron smithii, Barton*)	3#
Sideoats grama (*Bouteloua curtipendula Vaughn*)	4#
Blue grama (*Bouteloua gracilis*)	1#
Blue flax (*Linum Lewisi*)	1#
Penstemon (*Penstemon eatonii*)	1#

A preference to seeding by drilling is given in all areas that are neither too rocky nor too steep. Straw mulch is used over these seeded areas at 2-1/2 tons to the acre where it can be crimped into the soil. In areas where the straw is not easily crimped it is held in place with a tacking agent. In these areas the rate is reduced to 1-3/4 tons per acre, to prevent excessive shading of the soil surface and to more effectively tack the straw in place. The tacking agent most often is an organize blinder at 150 pounds per acre in a slurry of 700 gallons of water and 400 pounds of wood fiber.

During the last 10 years the Department has seeded over 7,000 acres at a cost that has gradually increased to average over $1,000 per acre. Hydroseeding and mulching is used only in areas where other methods are not appropriate because of slope, location or soils.

Among the native plants that we have seeded are the following slides:

1. Cercidium floridum - Blue Palo Verde, the Arizona State Tree. Bailey MultiRada
2. Sporalsla Desert Globe mallow
3. Cassia covesii
4. Lupinus Arizonicus
5. Eschollzia Mexicana - Mexican poppy
6. Encelia farinosa - Brittlebush
7. Kallstromia grandiflora - Arizona poppy
8. Bladderwort
9. Sand verbena
10. California bluebells
11. Gullardia puchella - Indian blanket
12. Dysodia pentaflora
13. Zinnia acerosa
14. Penstemon

Seed availability is frequently limited or not available for many species. Some seed collectors are beginning to grow the various species which is helping to assure availability as well as lower the price.

Developing a Vegetation Management Program

Roy L. Smith, Texas State Department of Highways and Public Transportation, Austin, Texas

Simply stated, vegetation management is the growing and managing or maintaining vegetation to accomplish a particular goal. The objective defines or narrows the parameters in which you work to achieve or accomplish this goal with regard to vegetation management.

In Texas the highway system crosses ten different major vegetational areas and encompasses approximately 1,050,000 acres. The goal is to have a highway right-of-way that is compatible if possible with the adjacent property and blends with the vegetation zone through which it passes. The objectives are to preserve, select, establish, and maintain vegetation on the highway right-of-way which achieves the goal established.

This may seem a bit mechanical in its approach, but you must know what you want to achieve in order to develop a vegetation management program.

To achieve the desired vegetation there must be a committment to the objectives set forth and this should start prior to construction activities.

The first phase of a vegetation management program is to preserve the existing native vegetation. This may involve limiting areas to be disturbed during construction. This not only preserves valuable vegetation, but also reduces the areas which need to be revegetated.

Secondly, there should be a knowledge or understanding of the vegetational area to properly select grasses, wildflowers, and landscape plants to be used in restoring the disturbed areas. These plants should be selected with regard to their ability to revegetate or establish, maintenance requirements, and aesthetics desired. Also availability of seeds and plants is an important consideration.

Thirdly, proper planting techniques must be explored and refined or even developed to insure establishment. The best planting time must be determined to achieve survival. Proper planting rates and mixtures must also be determined to achieve the desirable cover. In landscape plantings the quantity of plant material and spacing of plants must be determined to achieve the desired impact or design statement.

Fourthly, proper maintenance is essential to achieve the desired results. Maintenance has been mentioned in the

selection of plant material and once planted this maintenance activity must be carried out to promote establishment. This maintenance may be watering, fertilizing, selective weeding, and mowing. Many times reseeding or replanting may be necessary to maintain or achieve the desired results. It is during this fourth stage when the word management normally plays a part. As the right-of-way develops proper management tools will need to be used. With respect to function of a highway system, these management practices should promote a safe and pleasing experience for the travelling public as well as protect the investment.

The aforementioned criteria are implemented in Texas in the following ways. Grass seeding specifications have been written to involve the native grasses for each of the ten vegetational zones. Planting techniques have been researched and continue to be updated. Wildflowers for each area of the State have been identified as to their adaptability and availability.

Landscape plantings use as many native plants as possible, depending on availability and design requirements. Ornamentals are used when and where they are needed to achieve the design concept. Temporary irrigation is also designed and included in the contract plans to increase establishment. Supplemental maintenance contracts are also used to reduce the impact on already burdened maintenance forces.

Mowing standards have been developed to give guidelines for safety mowing, wildflower preservation, cutting heights, and designated non-mow areas. Along with mowing standards there is a herbicide program designed primarily as a pest plant management tool. Herbicides are used to control vegetation along the edge of pavement and around highway fixtures (signs, delineators, guardrails). The herbicide program is designed to mesh with a limited mowing program and not to replace it. An example being to reduce the infestation of johnsongrass, thereby encouraging more desirable vegetation and reducing the need or frequency of safety mowing.

The emphasis in Texas is on a right-of-way which has a community of plants which blends with and enhances the environment. A weed is not a weed if it blooms in Texas; it is a wildflower.

Yellowstone National Park-Bridger Plant Materials Center Native Plant Program

Mark E. Majerus, Agronomist, USDA Soil Conservation Service, Plant Materials Center, Bridger, Montana

With the passage of the National Surface Transportation Assistance Act of 1982, Congress recognized a nationwide need for rehabilitating and upgrading deteriorating road systems in national parks. With Federal Highway Commission money, Yellowstone National Park initiated reclamation and landscape plans for the Craig Pass road project, a 30-kilometer stretch from Old Faithful to West Thumb. In the past, revegetation within Park boundaries was accomplished by natural means, i.e., plant propagules originating from salvaged topsoil or dispersing from adjacent, undisturbed plant communities. In 1986, through a cooperative agreement between the National Park Service (NPS) and the USDA-SCS Plant Materials Center (PMC) at Bridger, Montana, collections of seed were made of native, indigenous grasses, forbs, and shrubs. Seed collections were taken to the Bridger PMC, cleaned, and planted in seed production fields or propagation beds. Produced seed and plants are returned to the park for revegetation of disturbed roadsides.

The reasoning behind this revegetation approach is to be able to seed large areas with native, indigenous plant material and produce a plant cover faster than would be realized with natural succession. A quick plant cover will protect road cuts and fills from surface wind and water erosion, and will hopefully compete with invading weedy species. The decision to take this approach in road construction revegetation has created many unanswered questions and much controversy concerning the protection and preservation of the indigenous gene pool. Some of the questions, for example, are:

1. Because the roadway creates an artifically exposed site within a forest community, what species can be considered indigeous to this site?
2. What constitutes the limits of a genotype; how far away can you collect and still be within these limits?
3. What species can be collected and produced using cultivation techniques?
4. By taking seed outside the park to a dissimilar climate to produce seed, is genetic drift or natural selection going to affect the genetic integrity of this plant material?, and
5. Is the planting of this collected and produced material going to significantly affect the development of plant material from the naturally occurring seed sources?

Through the activities of the Bridger PMC, an attempt is being made to answer some of these questions.

Seed Collection

When a roadway is constructed through a forest plant community, the native species for these exposed road cuts are no longer the forest and understory species, but rather those species that would invade and colonize on these exposed sites. By examining abandoned roads, old disturbances, and open park and meadows within the predominantly lodgepole pine forest types, it was possible to get an idea of the species that should be utilized. All seed collections were within Park boundaries and within 8-10 kilometers (km) of the reclamation sites for which they were to be used. The genetic variability within and among plant population varies by species based on geographic range, reproductive mode, mating system, seed disposal mechanism, and stage of succession (Hamrick 1983). Whether a species is self-pollinating or outcrossing also makes a difference in genetic variability. The selfing mode of reproduction limits the movement of alleles from one population to another and consequently increases genetic differences among populations. Plant species with wide ranges, long generation time, wind pollination, outcrossing mating systems, and that occur in the later stages of succession tend to have low variability within population and high variability among populations. Pioneer (early, successional) species also have less genetic variation within populations. The NPS is proposing a collection restriction of 5 km on short-lived, selfing species; 8 km on short-lived, outcrossing species; and 16 km on long-lived, outcrossing species. Currently, the interpretation of what constitutes a gene pool and the limits of a plant population does vary among the different national parks.

Seed collection within YNP utilizes a variety of seasonal laborers and volunteers under the supervision of the landscape architects and PMC plant specialists. Although various vacuum harvesters had been tried, most of the collection is done by hand stripping or using hand scythes. Harvested material is air dried and then transported to the Bridger PMC for cleaning. Since 1985, 360 seed collections of 119 species have been made from 100 separate sites in YMP. Table 1 lists the major species collected and the rate of seed harvest. The speed at which seed can be collected depends on the stand densitry, degree of seed set, and the persons collecting. This table gives an idea of the time and expense of hand harvesting native plant materials.

Table 1. – *The major species collected in Yellowstone National Park and the rate at which the seed can be hand collected.*

Genus & Species	Average Collection Rate*(g/manhr)*	Range
Leymus glaucus	512	75-2552
Elymus trachycaulus	454	136-976
Poa species	349	54-580
Bromus marginatus	294	33-1008
Agrostis species	95	29-140
Deschampsia cespitosa	87	38-141
Festuca idahoensis	85	56-162
Elymus elymoides	78	16-195
Stipa occidentalis & richardsonii	49	18-66
Stipa comata	36	21-68
Genus & Species	**Average Collection Rate*(g/manhr)***	**Range**
Achillea millefolium	162	125-188
Penstemon species	156	20-454
Chaenactis douglasii	148	21-267
Helianthella uniflora	130	69-214
Eriogonum umbellatum	121	37-263
Phacelia hastata	69	4-300
Lupinus species	61	9-222
Aster integrifolius	55	3-136
Anaphalis margaritacea	55	3-149
Solidago species	50	25-65
Potentilla species	40	12-110

Seed and Plant Production

The Bridger PMC is located approximately 160 km northeast of YNP on 55 hectares of irrigated land. The elevation is 1,128 meters, and the average growing season is 130 days. Seed is being collected from sites at 1,800 to 2,400 meters that have less than a 100-day growing season. Seed of alpine plants (3,000 m elevation) have been successfully produced in the past at the PMC. The biggest short-coming of this site for producing seed of mountainous species has been the hot, dry spring weather. However, seed of the short-lived, self-pollinating species such as mountain brome *Bromus marginatus*, slender wheatgrass *Elymus trachycaulus*, blue wildrye *Leymus glaucus*, and bottlebrush squirrel tail *Elymus elymoides* are relatively easy to raise.

Seed production fields are established by seeding 1-m spaced rows at a rate of 90 pure live seeds per linear meter of row. Fields are flood irrigated, fertilized (60 kg nitrogen/hectare, 40 kg phosphorus/hectare) and cultivated following standard procedures used by most commercial seed rowers. Extensive hand roguing is used to minimize contamination with weeds or off-types. Depending on the species and the size of the field, seed is harvested by hand or with a small combine. A Woodward Flail-Vac has been purchased to harvest the more difficult species, i.e., those with long awns or those that readily shatter.

In an attempt to determine if there is any genetic drift or natural selection when seed is produced at a site remote from the national park, Glacier National Park is funding a study at the University of Montana. Seed of three generations of mountain brome (original collection and two subsequent generations grown at the Bridger PMC) have been submitted for electrophoretical analysis and phenological comparison. Merrell (1981) stated that individuals developing at the same time, but under different environmental regimes, may have different phenotypes develop, even though their genotypes are essentially the same.

Forbs and shrubs for transplanting have been produced from seed and cuttings in the greenhouse in 164-cm³ conetainers[1] or grown in outdoor propagation beds. Species successfully grown are listed in table 2.

Table 2. – *Species grown in cone-tainers in a greenhouse or in propagation beds for transplanting back into YNP on disturbed sites.*

Conetainers/Greenhouse	
Helianthella uniflora	heterotheca villosa
Eriogonum umbellatum	Phacelia hastata
Anaphalis margaritacea	Potentilla species
Geranium viscosissimum	Antennaria species
Geranium richardsonii	Aster integrifolius
Achillea millefolium	Arenaria congesta
Penstemon cyaneus	Arnica species
Chaenactis douglasii	
Propagation Beds	
Berberis repens	Ribes idaeus
Prunus virginiana	Ribes species
Rhus trilobata	Acer glabrum
Cornus stolonifera	Rosa species
Symphoricarpos species	

Seeding Trials

Construction on the first 15 km section (Kepler Cascades to DeLacey Creek) was completed in the fall of 1988. At this time all cut and fill slopes were seeded with native indigenous plant materials that were either collected and grown at the bridger PMC or collected for direct reseeding. Because this was the first planting of this kind within YNP, plots were set up to monitor plant establishment and longevity along this road project.

Methods and Procedures

Seed Mixture Trials

In October of 1988, plots were set up on two topsoiled slopes, a south-facing slope (near Kepler Cascades) and a north-facing slope (near Scaup Lake). Replicated plots (22.5 square meters) were established in a split-split block design with mulch treatments (mulch-no mulch) as the main plot. Bark mulch (one-third cedar and two-thirds fir) was applied to a 2.5 cm thickness. The fertilizer treatments (fertilizer-no fertilizer) were arranged as subplot treatments. Fertilizer was applied at a rate of 10 kg nitrogen/metric ton of bark mulch. The seed treatments (seed-no seed) was arranged as sub-subplots. The seeded plots were hand broadcast with a mixture of native, indigenous grasses and forbs (table 3), while the unseeded plots relied on a seed bank in the replaced topsoil and seed dispersal from adjacent, undisturbed plant communities.

Table 3. – *Species and amounts seeded in test plots at Kepler Cascades and Scaup Lake in Yellowstone National Park on October 14, 1988.*

Genus & Species	Seeds /Gram	Seeds Used *(gram)*	Seeds /Meter²
Elyumus trachycaulus	335	232	123
Agrostis scabra	6,060	40	260
Bromus marginatus	150	386	96
Leymus glaucus	280	160	73
Phleum alpinum	1,575	73	136
Elymus elymoides	270	150	69
Lupinus argentea	65	36	0.3
Potentilla gracilis	3,330	80	358

Ten, random, 20- X 40-cm frames in each plot are being sampled three times during the growing season at approximately 5-week intervals so as to document plant mortality and plant composition changes.

Forb Trials

In the spring of 1989, on the first 15-km section of road, several greenhouse-grown, containerized forbs were transplanted along the roadway. This was a very labor intensive and impractical method of establishing forbs. If some of the pioneer-type forb species could be established from seed, the reclamation process would be simplified and more expedient. On the second 15-km section of road, replicated plots were established in October 1989 to compare germination, establishment, and longevity of twelve forb species (table 4).

Table 4. – *Species included in the Forb Trials[1] (1.5 m X 4.5 m plots, 3 reps CRB) on a south-facing cut near Little Thumb Creek, along the Craig Pass road project in Yellowstone National Park. Planting was established September 28, 1989.*

Genus & Species	Seeds/gram	Seeding Rate *(grams/plot)*
Achillea millefolium	5,950	2
Antennaria umbrinella	13,200	1
Anapalis margaritacea	18,100	2
Arnica latifolia	900	3
Aster species	440	5
Chaenactis douglasii	680	5
Chrysopsis villosa	595	5
Eriogonum umbellatum	460	8
Lupinus species	65	25
Phacelia hastata	340	15
Penstemon cyaneus	395	8
Solidago species	1,540	4

[1]All plots were overseeded with a mixture of Elymus trachycaulus (68 g) and Bromus marginatus (147 g), equivalent to 70 seeds/m² of each species.

Five, random, 20-X40-cm frames in each plot were also evaluated three times during the growing season to monitor seedling survival and mortality.

Results

Seed Mixture Trials

The fertilizer that was applied to the fertilized plots (10 kg/ metric ton of bark mulch) was the recommended amount to compensate for the nutrients required for the microbial decomposition of the mulch. During the first two growing seasons, there were no significant differences in plant density or composition among the fertilized and non-fertilized plots on either the south-facing (Kepler) or north-facing (Scaup) plots. (See figures 1, 2, and 3). There is apparently no need to apply fertilizer, at least at this low rate.

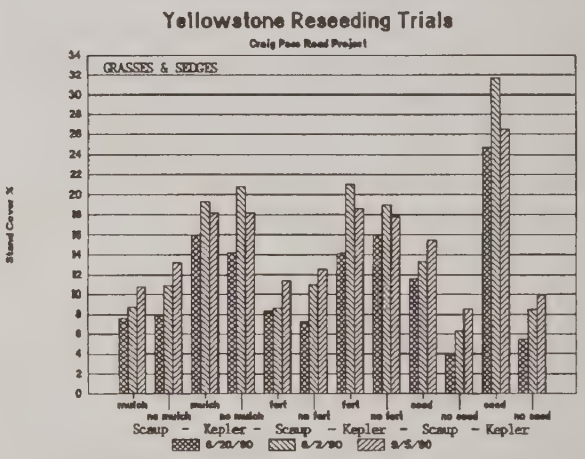


Figure 1. – *Percent cover of grasses and sedges in plots at Scaup Lake and Kepler Cascades. A comparison of three treatments at three dates during the 1990 growing season.*

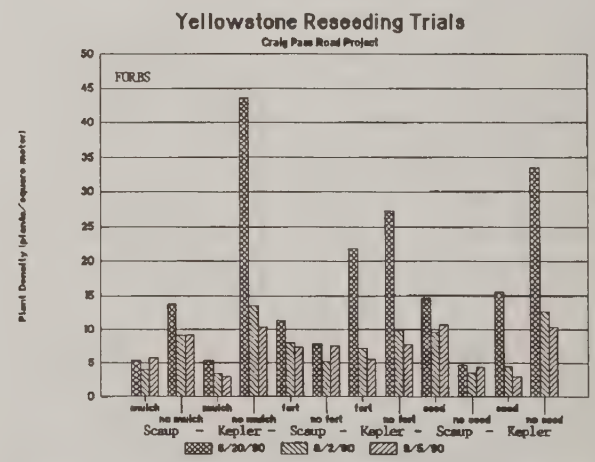


Figure 2. – *Plant density of forbs (both seeded and invading) in plots at Scaup Lake and Kepler Cascades. A comparison of three treatments at three dates during the 1990 growing season.*

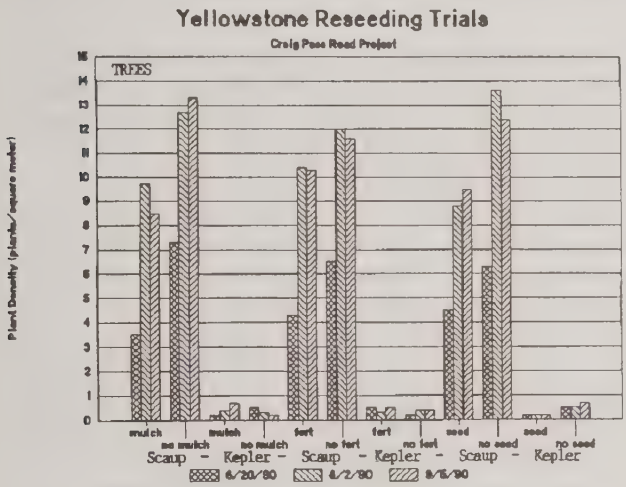


Figure 3. – *Plant density of lodgepole pine in plots at Scaup Lake and Kepler Cascades. A comparison of three treatments at three dates during the 1990 growing season.*

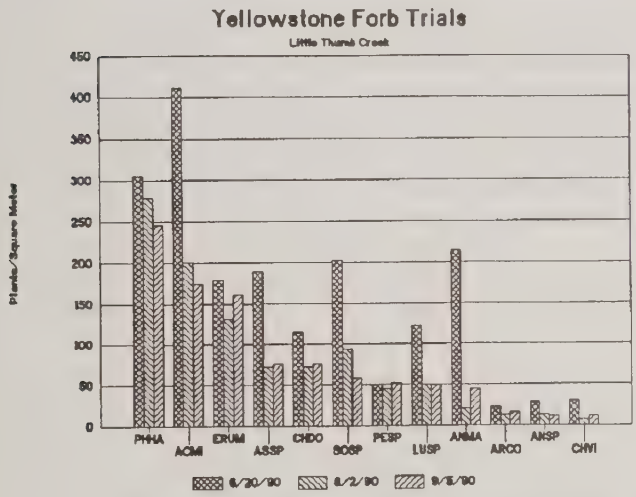


Figure 4. – *Plant density of forb seedlings in replicated plots near Little Thumb Creek at three dates during the 1990 growing season.*

The bark mulch treatment was applied to the cut and fill slopes along the entire road project to protect against surface erosion and to help retain surface moisture for better seedling establishment. When the contractor applied mulch to the plots, portions of the Scaup Lake plots were covered with 5-10 cm of mulch. The excessive mulch resulted in slower establishment and a significantly lower stand density the first year. However, during the second year there were no significant differences among the mulched and unmulched plots at either site. On the unmulched, unseeded plots at Kepler Cascades (south-facing slope), an annual forb, groundsmoke Gayophytum diffusum, established a dense stand, while on the mulched, unseeded plots there were only a few scattered plants. Mulching had considerably restricted this plant's establishment. Although mulching did not help develop better plant stands on the first section of road (1988 seeding), the late mulching (June rather than previous October) may have been a contributing factor to the relatively poor stands on some of the slopes on the second section (1989 seeding).

Significantly better plant cover was established by seeding with a mixture of native, indigenous species than by relying on the seed bank in the salvatged topsoil. An analysis of topsoil samples, prior to planting, indicated that only seed of sedges Carex species, lodgepole pine Pinus contorta, lupine Lupinus species, and pussypaws Spraguea umbellata were present. In the unseeded plots at Kepler Cascades and Scaup Lake, these were the only species to establish the first year.

Germination was later and plant development was slower at the Scaup Lake plots than at the Kepler Cascade plots because of the cooler soils and less exposure on the north-facing slope. After two growing seasons, all the seeded grasses at Kepler Cascades were headed out and produced viable seed; while at Scaup Lake the plants had a much shorter stature, and only a few of the grasses headed out. Also at Kepler Cascades, most of the forb and tree seedlings perished by the end of the first growing season, while at Scaup Lake most have survived two growing seasons. Thus far the best seeded grasses have been mountain brome, rough bentgrass, and slender wheatgrass (table 5). The sedges—Ross sedge *Carex rossii* and elk sedge *Carex geyeri*—are dominating the unseeded plots. There are similar numbers of sedge plants established in the seeded plots, but because of competition from the seeded grasses, the individual sedge plants are smaller. The seeding of these slopes has not restricted the establishment of those plants originating from the natural seed bank. The plant communities that will persist on these slopes will be a combination of plants originating from the natural seed bank and the seeded material—all of which are indigenous to disturbed sites in close proximity of this road project.

Table 5. – *Average plant composition of seeded and unseeded species over all seeded plots at the two test sites along the Craig Pass Road Project in Yellowstone National Park. Estimates made on 9/14/89 and 9/5/90.*

Genus & Species	Scaup Lake % Composition		Kepler Cascades % Composition	
	1989	1990	1989	1990
SEEDED: Bromus marginatus	19	26	21	34
Elymus trachycaulus	14	18	15	24
Argrostis scabra	18	20	30	15
Elymus elymoides	5	10	8	7
Leymus glaucus	10	1	5	2
Phleum alpinum	9	1	7	4
Lupinus species	3	2	2	1
Potentilla gracilis	7	5	4	1
			8	10
NONSEEDED: Carex species	13	15	1	Trace
Pinus contorta	—	—	Trace	Trace
Epilobium angustifolium	Trace	Trace	Trace	Trace
Spraguea umbellata	—	—	Trace	2
Gayophytum diffusum				

Forb Trials

The south-facing slope used for the replicated forb plots was not mulched so as to provide a more severe environment on which to screen forbs for potential reclamation use. Yarrow (*Achillea millefolium*) had the highest plant density (400 plants/m²) in early summer, but more than half of these seedings died by September (figure 4). Those yarrow plants that did survive are very strong, healthy plants. Silverleaf *phacelia Phacelia hastata* had the best seedling density at the end of the growing season. Sulfur buckwheat *Eriogonum umbellatum* not only had one of the lowest mortality rates during the summer, but it also had the highest rate of late germinating seeds. Most of these forbs can be easily collected, cleaned, and seeded. Yarrow is the easiest species to grow for seed production on a large scale. Because of poor seed set and often sparse native stands, both Arnica and Antennaria are difficult to collect and are not easily produced under cultiuvated conditions.

Literature Cited

Hamrick, James L. 1983. The distribution of genetic variation within and among natural plant populations. p. 335-348. In C. M. Schoenewald-Cox, S. M. Chambers, B. MacBryde, and L. Thomas (eds.), *Genetics and conservation, a reference for managing wild animal and plant populations.* Benjamin/Cummings Publ. Co., Inc., Menlo Park.

Merrell, David. 1981. Ecological genetics. University of Minnesota, Minneapolis.

Innovative Devices for Rangeland Seeding

H. T. Wiedemann, Professor, and B., T. Cross, Research Associate, Texas Agricultural Experiment Station, Vernon, Texas

Abstract

Since 1970, the Texas Agricultural Experiment Station has conducted a program to develop range seeding equipment which has produced several notable advancements. The most significant was a seed metering device of our design which reduced the variation in seeding rates of chaffy grass and it became the industry standard for grass drills. Six manufacturers of the device market over 85% of the grass drills. An advancement in aerial seeding was the adaptation of a positive dispensing system controlled by a microprocessor and radar to uniformly meter slick seed by compensating for variation in ground speed. A novel development for seedbed preparation was a disk chain designed to disk extensive acreages of debris-littered rangeland at pulling costs less than $15.00/ha ($7.00/ac). In cooperation with an Australian inventor, our current research is concentrating on a chain diker which incorporates a rotating anchor chain modified to produce a broadcast pattern of small basins 10-cm (4-in) deep. When the diker is pulled behind a disk chain, the combination provides tillage, land smoothing and basin formation and has increased seeded grass densities three fold compared to non-diked treatments.

Problem

Revegetation of rangeland with desirable forage plants could substantially improve livestock production and wildlife habitat. However, the practice has been hampered by the lack of properly designed equipment and the high cost of land preparation and seeding. Modified cropland equipment usually requires extensive and costly land cleanup before it can be used, and still, it may be plagued with problems. Seeding regimes often are orchestrated for a very high level of success when less costly techniques would give adequate results. Novel approaches are needed to encourage range revegetation.

Research was initiated by the Texas Agricultural Experiment Station (TAES) in 1970 to develop innovative equipment and more reliable techniques for rangeland rehabilitation. Early studies by Wiedemann and Brock (1975) found that land rootplowed for brush control is often too littered with brush debris to revegetate with conventional equipment. This paper describes a one-on-one poster presentation concerning several innovative technologies developed by TAES over the past 20 years on rangeland seedbed preparation and seeding that requires a minimum of land cleanup.

Surface Seeding Innovations

New Technology: Semi-circular seedbox with auger agitator for chaffy seed metering.

Significance: The seed metering device reduced variability in seed dispensing and it has become the industry standard. Six manufacturers of the device represent over 85% of the market. Over $200 million of grass seed has been planted with the device, and drill sales have been estimated at $10 to $20 million to meet the CRP demand. A Texas based company is one of the leading manufacturers.

Supporting Statement

Uniform metering of chaffy seeded grasses from drills has been a serious problem for many years (Brock et al., 1970). Moreover, much of the seeding equipment has been designed for clean-tilled land and does not withstand the rigors of rough land. To overcome the metering problems, a semicircular seedbox was constructed and several styles of agitators and pickerwheels were evaluated using sideoats grama (*Bouteloua curtipendula*) seed. A combination of the semicircular seedbox, auger agitator and 12.7-mm-wide (0.5 -in) pickerwheel with eight teeth gave the best results. This experimental metering device resulted in a seeding rate decrease of only 15% while metering 75% of the seed from the seedbox at a pickerwheel speed of 10 rpm (Figure 1). This compares to a seeding rate decrease of 99% before 75% were metered from the seedbox of a standard Nesbit rangeland drill using a pickerwheel speed of 30 rpm. Initial seeding rates were comparable for both units. The experimental unit easily metered 97% of the seed from the seedbox during static test conditions (Wiedemann et al., 1979).

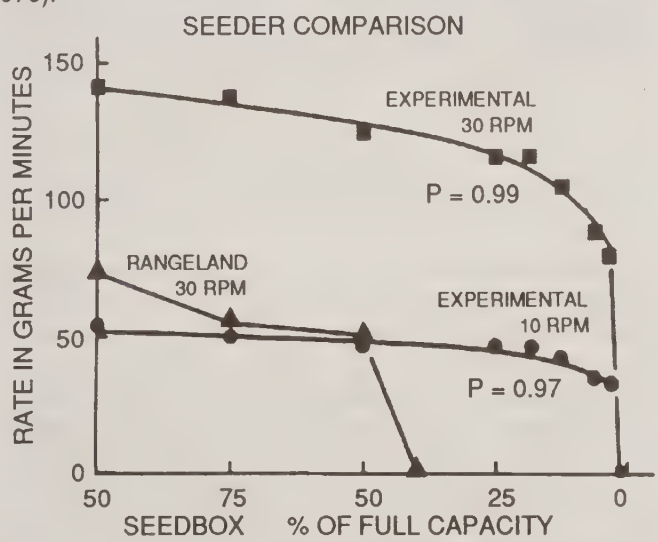


Figure 1. – Comparison of uniform seeding rates of the experimental chaffy seed metering device to the non-uniform rates of a standard rangeland metering device (Wiedemann et al., 1979).

Experiments also were conducted with caucasian bluestem (Bothriochloa caucasicus), little bluestem (*Schizachyrium scoparius*), buffelgrass (*cenchrus ciliaris*), galleta (*Hilaria jamesii*), fourwing saltbush (*Atriplex canescens*) and winterfat (*Ceratodes* lanata). The semicirular seedbox with auger agitation dispensed at least 97% of the seed of each species from the box. Seeding rate as a function of the amount of seed in the hopper was predicatable with significant r^2 values over 0.90 based on regression analysis. Buffelgrass seed, one of the most difficult to meter, had a decrease in seeding rate of only 33% while metering 75% of the seed from the seedbox. These experiments are described by Wiedemann (1982 and 1984).

A prototype seeder with the chaffy seedbox was mounted on a heavy-duty frame with flexing runner openers capable of traversing a 30-cm (12-in) log (Wiedemann and Cross, 1981) (Figure 2). Five years of field testing on debris-littered land is discussed by Wiedemann et al. (1979). Seedling densities in areas planted with the experimental seeder were 107% greater than similar areas seeded aerially.

Figure 2. – Prototype rangeland seeder with chaffy seed metering device and individual hoppers for slick seed, and flexing runner openers to place seed in he furrow without undue breakage from brush debris. Foam-filled tires prevent flats.

Both the seed metering and placement devices functioned well; however, acceptance of the technologies differed. The chaffy seed metering system became the industry standard. The flexing, runner openers have been used on a very limited basis because log-littered land is usually raked if a surface seeder is to be used. Raking allows drill seeders with double-disk openers to be utilized, and the lack of debris allows vehicle travel in the pasture.

Aerial Seeding Innovations

New Techology: Vaned rotor with microprocessor controls for positive metering of slick seed.

Significance: Aerial seeding is a viable option for rangeland, but conditions for success are more critical than those for drill seeding. Positive metering systems are accurate and they can be calibrated on the ground. Our average coefficient of variation was onlty 4% for 27 plots metering 1 to 3 bulk kg/ha (1 to 3 bulk lbs/ac). A radar speed sensor can be attached to compensate for ground speed variation. Freshly disturbed soil is critical for success. Disked seedbeds resulted in significantly better grass stands than seedbeds prepared with less soil disturbance. Soil crusted by rainfall reduced broadcast seeded stands by 80% compared to drill seedings; however, when soils were freshly disturbed there was little difference between the seedings. Aerial seeding has been widely used.

Supporting Statement

Aerial seeding offers a fast method for covering extensive areas of rangeland, but metering of grass seed from aircraft has posed numerous problems. Hard, slick seed flows evenly through the standard hopper gate opening only at high rates. When low seeding rates (0.5 to 2 kg/ha [0.5 to 2 lbs/ac]) of small slick seed are attempted, metering is erratic. A fluted baffle was developed that substantially improved dispensing (Wiedemann et al., 1980), but precision was not considered adequate.

Positive Metering Systems. Positive metering devices were researched by Bouse et al. (1982) and commercially developed by Elanco Products[1] 'Meterate' (Elanco) and Jack Duke 'Duke Metering System' (Duke). The vaned-rotor metering devices designed for pelleted products were adapted for grass seeding by Wiedemann (1985) (Figure 3). Without rotor modification, very small slick seed like lovegrass (*Eragrostis curvula*) or hulled bluestem (*Bothriochloa ischaemum*) must be mixed with a filler, such as ground milo on a 1- to-1 ratio by weight, to be metered accurately. Slightly larger seed, e.g. kleingrass (*Panicum coloratum*) or coated seed, meter well without rotor modification or filler. Field tests with the system resulted in an average coefficient of variation for 27 plots of 4.0% (Wiedemann and Cross, 1985a). During testing we determined that the metering system could be satisfactorily calibrated with the aircraft on the ground. Seeding rate could be adjusted by changing the rotor speed the same percentage that the actual seeding rate had deviated from the desired rate. Both the Elanco and Duke systems are available from Transland Aircraft, 24511 Frampton, Harbor City, CA 90710.

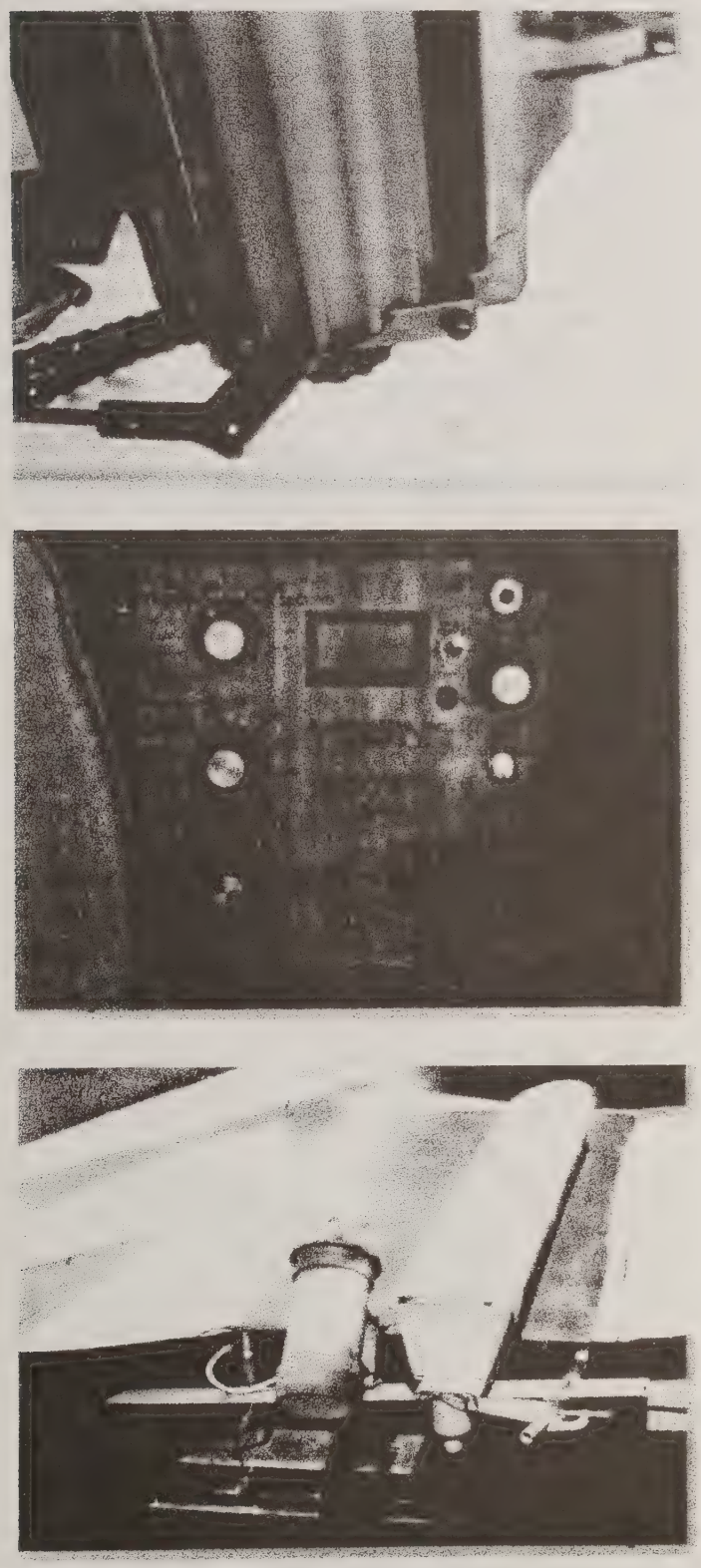


Figure 3. – Vaned rotor in positive meter system adapted for slick seed metering from aircraft (top view), computer device to control rotor speed (middle view), and radar speed sensor to measure true ground speed (bottom view).

Following these tests, Jerry Gebhiem, President, AgRobotics, Inc., Childress, TX developed a computerized speed control using a radar sensor to determine true ground speed for the aircraft's positive metering system. The desired seeding rate could be entered on the computer. A calibration check/adjustment was required while the plane was on the ground. In the air, the computer adjusted the rotor speed to compensate for variations in ground speed. Exploratory tests were very promising. AgRobotics terminated the project and Harold Hardcastle, President, Hardcastle Ag-Air, Inc., Vernon, TX 76384 purchased the development. No further commercial development has been conducted.

Chaffey Seed Metering. The positive metering system function well with small slick seed, but it cannot dispense chaffy seed. Sideoats and less chaffy seed normally can be metered through a hopper gate. Chaffier seed require some type of modification so they can pass through the hopper gate without bridging (Hardcastle, 1983). The chaffy seed can be coated and they meter well. However, the coating process is expensive and not readily available to producers. Another approach is to dehull the seed with a "shucker" attachment on the Woodward Chaffy Seed Conditioner developed by Aaron Beisel in cooperation with the USDA-ARS at Woodward, OK (Dewald et al., 1987). This system uses high speed air to strip the subtending appendages from the caryopsis (grain) with little damage to the seed. The small caryopses can be metered accurately from a positive metering system (Wiedemann and Cross, 1985a). Seeding with caryopses is an excellent approach if the seed can be planted without serious effects on germination and emergence.

Another alternative is to blend the chaffy seed with ground milo at a 1-to-2 ratio of seed to milo by weight plus another slick seed filler such as sorghum almum (*Sorghum almum*), kleingrass or millet (*Setaria italica*) at approximately 1 kg/ha (1 lb/ac)). Commercially, this adds about $1.00/bulk kg ($0.50/lb) of chaffy seed. All of our aerial chaffy seed metering research has been with WW Spar bluestem (*Bothriochloa ischaemum (L.) Keng var. ischaemum).*

Timing of Aerial Application. During the 5-year equipment development phase, it was observed that timing of the aerial seeding in relation to rainfall was critical to seeding success. Results further indicated that disking prior to seeding improved grass stands significantly ($p < 0.05$) over other methods which disturbed the soil less (Wiedemann et al., 1979). Further studies conducted over a 3-year period showed that broadcast seeding (simulated aerial) on seedbeds crusted by rainfall reduced grass densities in excess of 80% compared to seeding on freshly prepared seedbeds (Cross, 1983). Therefore, there is a much higher probability that aerial seeding will be successful if it is

conducted on a freshly disked seedbed and prior to the period when rainfall is most probable. Other considerations are covered by Dewald and Wiedemann (1985).

Disk Chaining Innovations

New Techology: Disk blades attached to alternate anchor chain links to provide disking action on log-littered land.

Significance: Disk chaining can reduce rangeland disking costs as much as 66%. The unit can traverse logs, stumps and small shrubs thus often eliminating the need for raking. Development of a single tractor pulling technique and a flexing roller has enhanced its acceptability. Grass densities on seedbeds prepared by disk chaining and offset disking were not different but both were significantly better than chaining. Disk chains are being used by the Bureau of Land Management (Green Stripping to contain wildfires) and Forest Service in seeding projects. Drawbar draft and depth of cut can both be predicted. A 104 kW (140 hp) crawler tractor can pull a 12.2 m (40-ft) wide, 20-blade unit at 4.8 km/h (3 mph) for a cost of $14.87/ha ($6.02/ac) ($65.00/h).

Supporting Statement

Early studies by Wiedemann et al. (1979) on rootplowed land showed that seedbeds prepared with a heavy-duty offset disk consistently produced better grass stands than roller chopping or chaining, but log-littered land often precluded the disk's use. A disk chain was developed that could traverse debris, reduce the cost of rangeland disking and eliminate the need for costly raking (Wiedemann and Cross, 1982) (Figure 4). A disk chain is an anchor chain with disk blades welded to alternate chain links. Disking action occurs when the chain, with swivels attached to each end, rotates as it is pulled diagonally.

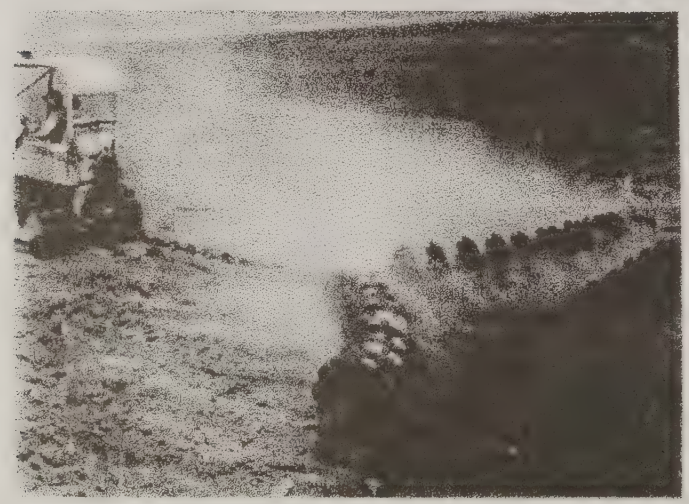


Figure 4. – Disk-chain developed for seedbed preparation on log-littered rangeland. Disking is achieved as anchor chain with blades welded to alternate links rotates.

Initially the disk chain was pulled diagonally between two tractors. Development of a triangular pulling method (Figure 4), which required only one tractor, decreased draft by 36% and increased the operating width by 23% over the two-tractor diagonal method (Wiedemann and Cross, 1985b). A draft measuring system for mobile equipment was developed for these studies (Wiedemann and Cross, 1983). Per-blade draft requirement of various combinations of disk blade and chain sizes within the range of 32 to 59 kg/blade (74 to 228 lbs/blade) is predicted by the relationship illustrated in Figure 5, addition of 1 kg (1 lb) of mass/blade increases draft by 18.3 N (1.9 lb of mass/blade icreases draft by 19.lbs) (Wiedemann and Cross, 1987). Disk blade cutting depth is also illustrated for various soil conditions.

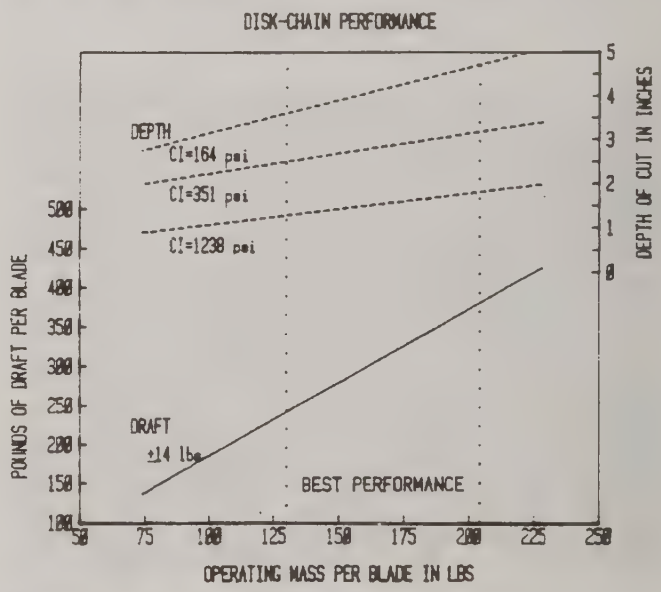


Figure 5. Draft and depth of cutting for various operating masses/blade of disk chains pulled in different soil conditions delineated by ASAE cone index values (Wiedemann and Cross, 1987).

An extensive discussion of the many engineering indices influencing performance is covered by Wiedemann and Cross (1990), including the development of a flexing joint in the roller (Figure 5) to traverse logs and stumps. Their work showed that the 64-mm (2.5-in) diameter anchor chain and 711-mm (28-in) diameter disked blades gave the best performance over a broad range of test conditions. Moreover, the disk chain has traversed 40x180-cm (16x72-in) logs and 60x90-cm (24x36-in) stumps on rootplowed land.

In seeding studies over a 3-year period, grass densities were increased 35 and 92% over seedbeds prepared by non-modified (smooth) chains in loamy sand and clay loan, respectively. There were no significant differences in grass densities between seedbeds prepared by disk chaining (7.2 plts/m^2 [0.67 plts/ft^2]) and offset disking (6.9 plts/m^2 [0.64 plts/ft^2), but both were significantly higher ($p < 0.05$) than chaining alone (4.7 plts/m^2 [0.44 plts/ft^2]) (Wiedemann, 1985).

The disk chain is being used by the Bureau of Land Management to install "green strips" to contain wildfires in the northwest United States (Pellant, 1989) and it has reduced costs in Forest Service seeding tests by two-thirds (Monsen, 1989).

Chain Diking Innovations

New Techology: Special shaped blades welded to anchor chain links to form basins for seedbed enhancement.

Significance: The chain diker forms about 45,000, 10-cm deep basins/ha (18,000, 4-in deep basins/ac). Pulling the chain diker behind the disk chain achieves tillage, land smoothing and basin formation in a single pass, and greatly improves the operation of the disk chain. The chain diker increases drawbar draft by 20% when it was pulled in combination with the disk chain. Grass densities were increased 3 fold in diked versus non-diked treatments when rainfall was 37% below normal;. Chain dikers are being used on flat-tilled cropland to reduce runoff. Diking increased wheat production by 11% compared to non-diked treatments when rainfall was below normal. When rainfall was 25% above normal, diking did not improve grass stands or wheat production compared to non-diking treatments; however, diking did reduce runoff by 21.2%. Agronomic units were designed to be pulled behind a disk, chisel or drill at 8 to 9 km/h (5 to 5.5 mph), and they required 2.2 drawbar kW/m (0.9 hp/ft) of width to be pulled at 8.1 km/h (5 mph). The novel diking technique appears promising.

Supporting Statement

The chain diker uses special shaped blades welded to opposing sides of each link of a large anchor chain. As it is pulled over tilled land, the chain rotates and the blades leave a broadcast pattern of diamond-shaped basins 10-cm (4-in) deep (Figure 6). Construction of the chain diker is in collaboration with its inventor, Bruce Smallacombe, Capella Sales and Engineering, Capella, Queensland 4702, Australia. When the chain diker is pulled behind the disk chain the combination tills, smoothes the land and forms basins all in one pass. The combination is called a "disk-chain-diker" (Figure 7). The chain diker can traverse any size brush debris the disk chain can travers.

Diking increased grass stand densities 3 fold compared to non-diked treatments (11.0 vs. 3.7 plts/m^2 [1.02 vs 0.34 plts/ft^2]) on disk-chain seedbeds when May/June rainfall was 37% below normal. In year 2, when May/June rainfall was 25% above normal (235 mm [9.24 in]), there was no difference in grass stands, all were excellent (15.9 plts/m^2 [1.48 plts/ft^2]). Diking appears to have the best potential to increase grass stands when rainfall is in short supply.

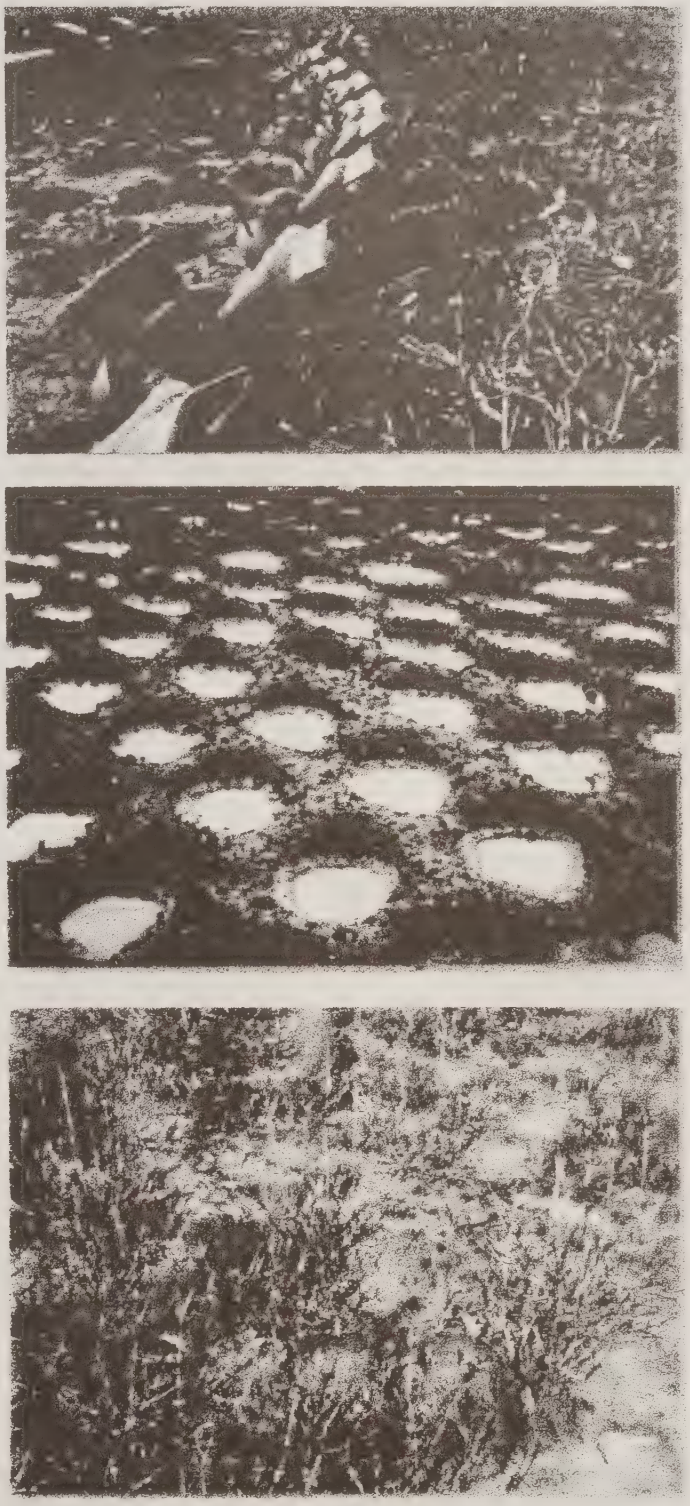


Figure 6. – Chain diker developed for enhanced seedbed preparation. Small basins are formed as chain rotates (top view). Small basins after rain (middle view) and grass plants in basins (bottom view). Technology is also useful to reduce runoff on flat-tilled cropland.

The basic disk-chain-diker is a 20-disk-blade unit using 64-mm (2.5-in) diameter anchor chain with 711 mm (28-in) diameter disk blades, a 500 mm (20-in) diameter flexing roller for a center brace (10.7-m (35-ft) wide), and a 76mm (3-in) diameter anchor chain with the special-shaped diking

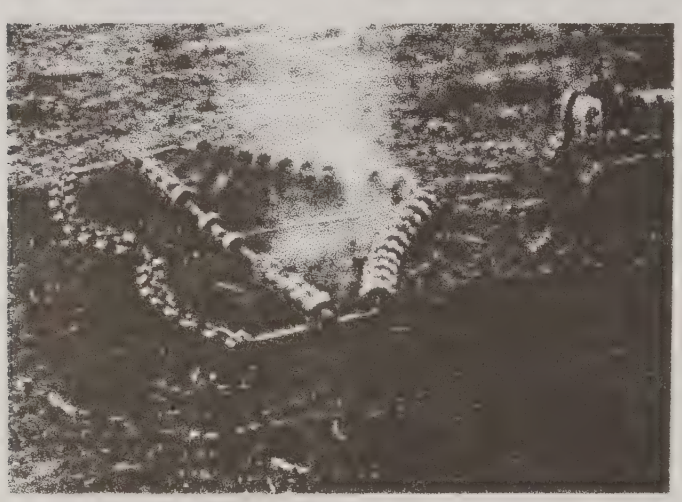


Figure 7. – The combined disk chain and chain diker implement provides tillage, land smoothing and basins formation all in one pass on log-littered rangeland.

blades (Figure 8). Average drawbar draft of this unit is 2.29 kN/blade 0.08 (515 lbs/blade 19) when pulled between 3.2 and 4.8 km/h (2 and 3 mph), the chain-diker unit accounted for 20% of the draft. The basic unit requires 3.03 kW (4.07 hp)/blade of drawbar power to operate at 4.4 km/h (3 mph) (Figure 8). The 20-blade unit is a full load for a 104 engine kW (140 hp) crawler tractor. At a contractor's rate of $65.00/hr for the crawler tractor, the pulling cost would be $18.45/ha ($7.47/ac).

Chain dikers show promise for reducing runoff on flat-tilled cropland. Agronomic units are designed to be pulled behind a disk, chisel or drill at 8 to 9 km/hr (5 to 5.5 mph) and cost about $1150/m ($350/ft). Required drawbar power for this style unit was 2.2 kW/m (0.9 hp/ft) of width at 8 km/hr (5 mph). Diking increased wheat production 11% ($p<0.05$, compared to conventional tillage the first year when rainfall was 16% below normal: however, ther was no difference in yield the second year when rainfall was 28% above normal (800 mm [31.5 in]). Runoff was reduced 21.2% ($p < 0.05$) by diking during crop season 2.

Further information on the chain diker and disk-chain-diker is covered by Wiedemann and Smallacombe (1989) and Wiedemann and Cross (1990), respectively.

Conclusions

The chaffy grass seed metering device significantly increased the stability of seeding rates for grass drills and became an industry standard.

Positive metering systems substantially reduced variability in aerial dispensing of grass seed. Since every lot of grass seed is slightly different and meters differently, the ability to

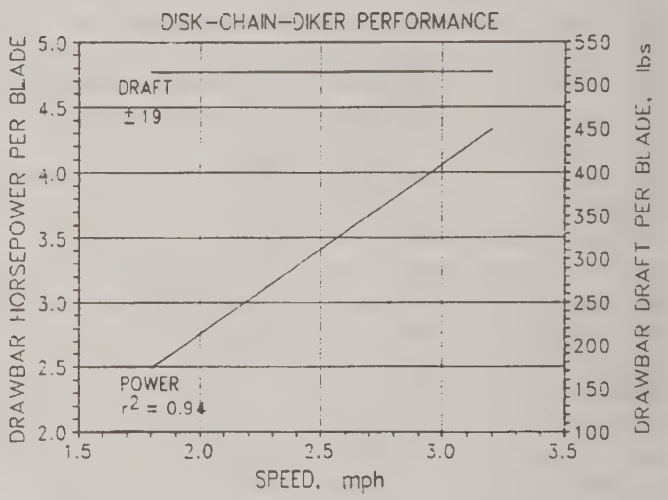


Figure 8. – Drawbar power and draft requirements of the basic disk-chain-diker for various speeds.

calibrate the airplane's metering system on the ground in a few minutes and then dispense load after load with little variation in seeding rate, is significant advancement. Seed modification allows the metering of chaffy grass seed, which previously was not possible.

The disk chain prepares an adequate seedbed for grass seeding on log-littered land, and it is cost effective.

Combining the chain diker and the disk chain has resulted in a novel method to till and smooth land and form basins all in one pass on log-littered land. Moreover, the basins enhance stand establishment when moisture is in short supply. The chain diker also shows promise for reducing runoff for flat-tilled crops.

These innovative devices offer effective techniques to rehabilitate rangelands worldwide.

References

Bouse, L.F., J.B. Carlton and J.C. Brusse. 1982. Dry metering system for aircraft. *Transactions of the ASAE* 25(2):316-320.

Brock, J.H., E.D. Robison, C.E. Fisher and C.H. Meadors. 1970. Re-establishment ofgrasses following mechanical removal of brush. PR-2810:43 in *Brush Research in Texas 1970.* Texas Agr. Exp. Sta. Consol. PR 2801-2828.

Cross, B.T. 1983. Seedbeds and seeding methods. P. 20 in H.T. Wiedemann and J.F. Cadenhead, eds., *Symposium Proc. Range and Pasture Seeding in the Southern Great Plains.* Texas A&M Univ. Agr. Res. & Ext. Ctr., Vernon, TX.

Dewald, C.L., V.A. Beisel and P.L. Sims. 1987. Concepts and principles of the Woodward chaffy seed conditioning system. *Symposium Proc. Seed and Seedbed Ecology of Rangeland Plants.* USDA-ARS. Tucson, AZ. P. 278-282.

Dewald, C.L. and H.T. Wiedemann. 1985. Improving rangeland seeding success. *Proc. of the 1985 International Ranchers Roundup.* Texas A&M Univ. Agr. Res. & Ext. Ctr., Uvalde, TX.

Duke, J. Duke Metering Equipment Company, Inc. Product literature. 559 Skyland Boulevard, Tuscaloosa, Alabama 34505.

Elanco Products Company, a division of Eli Lilly and Company. Product information. 740 South Alabama Street, Indianapolis, Indiana 46285.

Hardcastle, H.J. 1983. Experiences in commercial aerial seeding. Pages 44-45 in H.T. Wiedemann and J.F. Cadenhead, eds., *Symposium Proc. Range and Pasture Seeding in the Southern Great Plains.* Texas A&M Univ. Agr. Res. & Ext. Ctr., Vernon, TX.

Monsen, S. 1989. Personal communication. USDA-FS. Shrub Sciences Lab., Provo, UT 84601.

Pellant, M. 1989. Personal communication. USDI-BLM. Idaho State Office, Boise, ID 83706.

Wiedemann, H.T. 1982. Fluffy grass seed metering device for rangeland seeders. P. 178-182 in E.F. Aldon and W.R. Oaks, eds., *Symposium Proc. Reclamation of mined land in the Southwest.* Soil Conser. Soc. Of Amer. Albuquerque, NM.

Wiedemann, H.T. 1983. Fluffy seed metering systems for drills. P. 36-42. in H.T. Wiedemann and J.F. Cadenhead, eds., *Symposium Proc. Range and Pasture Seeding in the Southern Great Plains.* Texas A&M Univ., Agr. Res. & Ext. Ctr., Vernon, TX 76384.

Wiedemann, H.T. 1985. Advances in aerial grass seed metering. Paper No. 85-1504. ASAE, St. Joseph, MI 49085-9659.

Wiedemann, H.T. and J.H. Brock. 1975. Reseeding as affected by seedbed preparation, seeding methods and seeding rates following rootplowing. P. 38-40 in *Rangeland Resources Research 1971-74.* Texas Agr. Exp. Sta. Consol. PR3341.

Wiedemann, H.T., J.H. Brock, C.E. Fisher and B.T. Cross. 1979. Seed metering and placement devices for rangeland seeder. *Transactions of the ASAE* 22(5):972-977.

Wiedemann, H.T., C.H. Meadors, and B.T. Cross. 1980. Hopper-gate baffle for improved aerial metering of pelleted herbicides and seed. Pages 98-99 in *Rangeland Resource Research.* Texas Agr. Exp. Sta. Consol. PR 3665.

Wiedemann, H.T. and B.T. Cross. 1981. Rangeland seeder development using semicircular seedbox and auger agitator seed metering concept. *J. of Range Manage.* 34(4):340-342.

Wiedemann, H.T. and B.T. Cross. 1982. Draft of disk-chains for rangeland seedbed preparation. *Transactions of the ASAE* 25(1):74-76, 80.

Wiedemann, H.T. and B.T. Cross. 1983. Microprocessor with memory chip to collect transducer data on mobile equipment. *Agricultural Engineering* 64(11):7-8,11.

Wiedemann, H.T. and B.T. Cross. 1985a. Engineering systems for rehabilitation of arid lands. *Proc. Arid Lands: Today and Tomorrow.* Univ. of Arizona. p.871-881.

Wiedemann, H.T. and B.T. Cross. 1985b. Influence of pulling configuration on draft of disk-chains. *Transactions of the ASAE* 28(1):79-82.

Wiedemann, H.T. and B.T. Cross. 1987. Influence of operating mass on disk-chain performance. *Transactions of the ASAE* 30(6):1637-1640.

Wiedemann, H.T. and B.T. Cross. 1990. Disk-chain-diker selection and construction. Center Technical Report TR-1. Texas A&M University Research & Extension Center., Chillicothe-Vernon, Vernon, Texas 76384 (submitted).

Wiedemann, H.T. and B.A. Smallacombe. 1989. Chain-diker—a new tool to reduce runoff. Agricultural Engineering 70(5):12-15.

Attendance

Meeting			Participants				
Date	*Place*	*Presiding Chairman*	*Federal Gov't*	*State Gov't*	*Private*	*Foreign*	*Total*
Dec 1946	Portland[1]	Joseph F Pechanec	6	0	0	0	6
Dec 1947	Ogden[1]	" "	9	0	0	0	9
Jan 1949	Denver	" "	15	0	0	0	15
Dec 1949	Ogden[1]	" "	22	0	0	0	22
Jan 1951	Billings	" "	34	5	0	0	39
Jan 1952	Boise	A.C.Hull	45	9	0	0	54
Jan 1953	Albuquerque	" "	75	15	9	1	100
Jan 1954	Omaha	" "	63	8	3	5	79
Jan 1955	San Jose	W.W. Dresskell	62	10	4	1	77
Jan 1955	Denver	William D. Hurst	86	12	1	2	101
Jan 1957	Great Falls	" "	95	10	4	0	109
Jan 1958	Phoenix	Frank C. Curtis	87	9	3	0	99
Jan 1959	Tulsa	" "	84	5	2	0	91
Jan 1960	Portland	" "	98	10	3	3	114
Jan 1961	Salt Lake City	" "	123	11	14	2	150
Jan 1962	Corpus Christi	Frank Smith	58	5	7	1	71
Jan 1963	Rapid City	" "	52	6	1	0	59
Jan 1964	Wichita	John Forsman	61	10	5	0	76
Jan 1965	Las Vegas	" "	77	8	6	0	91
Feb 1966	New Orleans	" "	47	8	5	1	61
Feb 1967	Seattle	A. B. Evanko	58	10	4	0	72
Feb 1968	Albuquerque	" "	84	16	13	1	114
Feb 1969	Great Falls	" "	46	3	13	0	61
Feb 1970	Denver	" "	81	8	11	0	100
Feb 1971	Reno	" "	74	6	15	2	97
Feb 1972	Wash., D. C.	" "	48	3	6	0	57
Feb 1973	Boise	" "	60	7	7	4	78
Feb 1974	Tucson	Bill F. Currier	61	12	10	14	97
Feb 1975	El Paso[1]	Stan Tixier	49	9	11	1	70
Feb 1976	Omaha	" "	50	17	12	0	79
Feb 1977	Portland	Vern L. Thompson	63	26	31	10	130
Feb 1978	San Antonio	" "	68	26	35	6	135
Feb 1979	Casper	Ted Russell	74	35	72	12	193
Feb 1980	San Diego	" "	97	44	88	21	250
Feb 1981	Tulsa	" "	56	35	111	16	218
Feb 1982	Denver[1]	" "	60	18	68	5	151
Feb 1983	Albuquerque	" "	119	82	96	9	306
Feb 1984	Rapid City	Randall R. Hall	95	22	49	7	173
Feb 1985	Salt Lake City	" "	110	46	85	13	254
Feb 1986	Orlando	Gerald Henke	41	31	29	13	114
Feb 1987	Boise	" "	94	35	34	5	168
Feb 1988	Corpus Christi	" "	42	14	23	8	87
Feb 1989	Billings	" "	65	19	23	2	109
Feb 1990	Reno	" "	19	11	13	3	46
Feb 1991	Wash., DC	Steve Monsen	13	8	7	1	29
Feb 1992	Spokane	" "					

[1] Meetling not in conjunction with Society for Range Management meeting.

Notes:

Notes:

United States
Department of
Agriculture

Forest Service

**Technology &
Development
Program**

2200–Range
September 1992
9222-2842-MTDC

Rangeland Technology Equipment Council

1992 Annual Report

Rangeland Technology Equipment Council

1992 Annual Report

Participants:

U.S. Department of Agriculture
U.S. Department of the Interior
State and County Agencies
Industry Representatives
Educational Institutions
Ranchers
Foreign Countries

September 1992

Published by:

USDA Forest Service
Technology & Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801

Contents

Agenda

Spokane, Washington
Sunday, February 9, 1992

Welcome
Stephen B. Monsen, Outgoing Chairman
Range Technology Equipment Council

Introductory Remarks
H.T. Wiedemann, Chairman
Range Technology Equipment Council

Information and Publications
Dick Hallman
USDA Forest Service
Missoula Technology and Development Center

Reports

Riparian and Wetland Restoration
Nancy Shaw, Botanist
USDA Forest Service,
Intermountain Research Station,
Forestry Science Laboratory
Boise, Idaho

Steep Slope Preparation for Seeding
Douglas D. Basford, Forester
USDA Forest Service
Salmon National Forest
Salmon, Idaho

Seedbed Preparation In Cheat-Infested Range
Mike Pellant, Range Conservationist
Bureau of Land Management
Boise, Idaho

Site Preparation Bacteria
Ann Kennedy
USDA Agricultural Research Service
Pullman, Washington

Sagebrush Establishment Enhanced by Snowfencing
Stephen B. Monsen, Botanist
USDA Forest Service
Shrub Sciences Laboratory
Provo, Utah

Range Improvements
Jim Olivarez, Noxious Weed Specialist
USDA Forest Service
Northern Region
Missoula, Montana

Integrated Weed Management
Barbra Mullin, Weed Coordinator
Montana Department of Agriculture
Helena, Montana

Noxious Weed Seed Free Forages
Larry Hoffman, Extension Agent
Montana State University Extension Serivce
Helena, Montana

Biological Control
Jim M. Story
Montana State University
Western Agricultural Research Center
Corvallis, Montana

Herbicide Approved Equipment
Fred Oligschlaeger, President
Spratronics, Inc.
Bothell, Washington

Helicopter Application Equipment
Ken Glanz, Sales Representative
Simplex Manufacturing
Portland, Oregon

Drawings

Single copies of drawings are available from the Technology and Development Centers without charge.

Write to:

USDA Forest Service
Technology and Development Center
Building 1, Fort Missoula
Missoula, MT 59801

USDA Forest Service
Technology and Development Center
444 E Bonita Ave
San Dimas, CA 91773

Drawings From MTDC

B.C. Drag Chain Scarifier, No. 790

Disk Chain Implement, No. 757

Optional Dryland Sodder Bucket, No. 682

Modified Hodder Gouger, No. 583

Sprig Spreader, No. 652

Dryland Sodder, No. 631

Tubling Planter, No. 628

Basin Blade, No. 619

Horse Trap Trigger, No. 618

Mulch Spreader, No. 611

Dixie Sager and Modified Ely Chain, No 568

Tree Transport Container, No. 604

Tree Transplant Trailer, No. 670

Drawings From SDTDC

Pipe Harrow, RM 1-01 and 02

Brushland Plow, RM 2-01 to 22

Oregon Press Seeder Assembly (not complete) RM 19-01 to 07

Plastic Pipe Layer Assembly, RM 21-01-03

Reel for Laying Plastic Pipe, RM 14-01

Contour Furrowers, RM 25-01-14

Rangeland Drill Deep Furrowing Arms, RM 26-46 to 61

Steep-Slope Seeder, RM 33-01-18

Demonstration Interseeder for Rocky and Brushy Areas, RM 35-01-09

Reports

Range Handbooks

Richard G. Hallman, Program Leader, USDA Forest Service, Missoula Technology and Development Center, Missoula, Montana

Three range handbooks have been published by the Missoula Technology and Development Center and are now available from the Society of Range Management in Denver. These structural improvement handbooks consolidate numerous handbooks now scattered through many federal agencies into three volumes: *Fences; Facilities for Handling, Sheltering, and Trailing Livestock, and Facilities for Watering Livestock and Wildlife.* Each volume describes components, uses, advantages and disadvantages, safety and concerns, suggestions for redesign or new concepts for future development. Costs are included where possible. Pertinent books and articles are included in a bibliography in each volume.

***Facilities for Handling, Sheltering, and Trailing Livestock*, 8724-2809, September 1987.** This publication discusses facilities for wildland horse, sheep, and cattle management. The book describes corral systems (pens, alleyways, fences, and gates); restraining devices (loading, working, and squeeze chutes, cradles, and tables); and miscellaneous facilities such as dipping vats, spray pens, dusting alleys, back rubbers, and scales. Sheltering facilities include sheds, shade shelters, windbrakes, and feeding and watering devices. The section on trailing livestock describes driveways and driftways, low-water crossings, culverts, corduroy log crossings, and bridges. Facilities discussed may apply to wildlife as well as domestic animals, but specific information on wildlife management is not included.

***Fences* (8824-2803, July 1988).** This handbook consolidates information on planning, building, and maintaining fences. Information is included on: gathering site information; locating the fence; choosing a fence design; clearing the right-of-way; laying out the fence; and safety concerns. It describes components including braces and posts, brace designs, gates and materials and tools necessary to build a fence. Detailed descriptions of electric, wire, and wood fences are discussed.

***Facilities for Watering Livestock and Wildlife*, MTDC 89-1, January 1989.** This volume gives an overview of basic concepts, techniques, and equipment used to provide water for livestock and wildlife. These facilities are improvements that collect, transport, store, or provide access to water. Collecting water discusses wells, pump, windmills, dams, and reservoirs. Transporting water includes information on pumps and piping. Water storage describes reservoirs and storage tanks. The section dealing with access to water facilities describes methods of allowing wildlife and livestock to water without damaging the storage facility.

These volumes can be ordered from:

Society of Range Management
1839 York Street
Denver, CO 80206

There is a charge for each volume:

***Fences*, $10**

***Facilities for Watering Livestock and Wildlife*, $6**

***Facilities for Handling, Sheltering and Trailing Livestock*, $5**

Introduction

Dear RTEC Participants:

The RTEC session held in Spokane, Washington, February 8-10, was a milestone session. Each presentation had 100 to 110 people in attendance. Total attendance during the four hour program was estimated at 250. There were five presentations on Site Preparation and five presentations on Noxious Weed Management.

This is our third program under the acronym RTEC, which stands for Rangeland Technology and Equipment Council. In 1990 our informal Workshop (VREW), reorganized to reflect the diverse interests present in the he field of range management, and to incorporate all federal, state, and private land managers. We started in 1945 when there was a need to develop seeding equipment suitable for rangeland. Today the Council is focusing on high technology techniques as well as traditional equipment development for solving management problems.

Our recent programs have been featuring the various workgroups represented in the Council. These groups and chairs include:

Information and Publications
Dick Hallman, Chairman
USDA Forest Service
Missoula Technology & Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801

Plant Materials
Wendall Oaks, Chairman, SCS
Plant Materials Center
1036 Miller St.
Los Lunas, NM 87031

Fire
Phil Range, Chairman, BLM
Boise Interagency Fire Center
3905 Vista Ave.
Boise, ID 83705

Seeding & Planting
Harold Wiedemann, Chairman
Texas Agricultural Experiment Station
P.O. Box 2658
Vernon, TX 76384

Seedbed Ecology
Steve Monsen, Botanist
USDA Forest Service
Shrub Science Laboratory
725 N 500 E
Provo, UT 84664

Structure
Dan McKenzie, Range Specialist
USDA Forest Service
San Dimas Technology & Development Center
444 E Bonita Ave.
San Dimas, CA 91773

Weeds and Weed Management
Jim Oliverez, Noxious Weed Specialist
USDA Forest Service
Northern Region
Missoula, MT 59801

Our current project is the updating of the Revegetation Equipment Catalog. This is a two-year project and upon completion, it will be available through the Society for Range Management. If you know of equipment that should be listed, please contact us.

The 1993 Annual RTEC meeting will be held in Albuquerque, New Mexico. Our program will feature Decision Aids and Pinion/Juniper Management Strategies. We hope to see you there.

Sincerely,

Harold T. Wiedemann
Chair, Rangeland Technology and Equipment Council

Seed Propagation of Sedges and Rushes

Nancy L. Shaw and Emerenciana G. Hurd, Botanists, Intermountain Research Station, Forest Service, USDA, Boise, Idaho

Efforts to rehabilitate riparian and wetland disturbances in the Intermountain West have generated a demand for nursery stock of common sedges (*Carex spp.*) and rushes (*Juncus spp.*). Easily propagated vegetatively, "sprigs" or rhizome sections of species in both genera are commonly dug from sites near disturbances for immediate planting or production of container stock. However, adequate quantities of vegetative material are not always available, and in some cases field collection may cause environmental damage. Scheduling and logistics of harvesting, storing and propagating vegetative material and its possible contamination with weedy species present additional problems for growers. For these reasons we began investigating seed propagation of nursery stock or direct seeding as additional approaches for accomplishing revegetation objectives.

Inflorescences, Fruits, and Seeds

Sedge inflorescences consist of single or multiple spikes produced on reproductive culms. Fruits are small, leathery achenes, each enclosed in a persistent saclike perigynium. For species included in our studies (table 1), weight of achenes plus perigynia ranges from 0.5 to 2 million/lb, with an average of 1 million/lb.

Rush inflorescences range from panicles to open headlike structures. Fruits are capsules, each containing numerous tiny seeds. Seed weight for species under study (table 1) averages 39 million/lb and ranges from 14 to 69 million/lb.

Harvesting

Harvest dates for sedges and rushes vary with species, location, and site conditions. Ease of harvesting varies considerably with site conditions, plant density, and morphological characteristics of the species. It is likely that equipment and technology designed for hand harvesting native grass seeds may be used or modified to simplify collection of sedges and rushes. Collections adequate for research or production of nursery stock can be obtained by hand clipping inflorescences and dropping them into containers carried on a shoulder harness or belt. Readily disarticulating achenes of species such as C. microptera may be stripped from the inflorescences. Rush inflorescences with closed capsules are clipped; seeds can be shaken into a container if capsules have opened.

Greater quantities of seed would be required for direct seeding projects. Mechanical harvesters could be adapted for collecting from large monotypic stands on sites dry enough to permit their operation. Establishment of seed production plots on agricultural land would also increase seed availability. Problems such as wildlife or livestock use, insect and fungal infestations, and fluctuating soil moisture and water tables, could also be avoided or controlled by this approach.

Conditioning

Harvested material of both genera is sometimes quite wet and may require field drying to prevent molding. Sedge inflorescences or achenes can be spread over fine screens for drying. Screens must also be placed over material dried outdoors as achenes are easily scattered by breezes. Rush inflorescences are dried upright in large buckets.

Small collections of sedge inflorescences are conditioned by removing achenes from inflorescences using the palms of the hand or a rubbing board. The perigynium is not separated from the achene. Removal of coarse debris is adequate for direct seeding. High purities required for production of container stock are obtained using sieves (nos. 12 to 18), air screen cleaners, and seed blowers. Techniques and equipment for drying and cleaning small grass seeds could be adapted for use with larger lots of many sedge collections.

Rush capsules open during drying. Seed can then be shaken into a container and separated from chaff using a fine screen (0.3 to 0.6 mm openings). Capsules should not be crushed if high purity is required since it is difficult to separate fragments from the seed. Purities exceeding 90 percent are obtained by careful hand winnowing or by removing chaff with a fine stream of air.

Testing and Storage

Standard germination tests for sedge and rush species have not been developed. Viability determined by tetrazolium chloride staining is used to estimate seed quality. Viability of collections included in our studies ranges from 28 to 96 percent and has not declined after 14 to 17 months storage in closed glass containers at room temperature. Moisture content of these collections ranged from 6 to 8%.

Germination

Treatment to reduce fungal problems is often necessary when germinating sedge achenes. Work with tiny rush seeds is complicated by static electricity problems. These are alleviated by placing the seeds on a glass plate and manipulating them with a bamboo probe, both sprayed with

an antistatic product. A hand lens or microscope is essential for examining rush seeds or germinants.

The limited literature on germination of Intermountain sedge and rush species suggests that alternating temperatures, light, and a moist to wet environment are common requirements for germination, favoring seedling emergence on moist, open substrates free of competing vegetation (Hurd and Shaw 1992, Johnson et al. 1965). Nature and degree of dormancy as well as specific incubation requirements vary among species and likely among populations. Based on our experience, seed propagation is possible for nondormant lots of species such as *Carex lenticularis*, *C. subfusca*, or *Juncus articulatus* and those that respond positively to cold stratification (30 days at 3 to 5 degrees C, such as *C. amplifolia*, *C. nebrascensis*, *J. effusus*, and *J. ensifolius*. We are presently developing pretreatments to relieve dormancy of species not responding to stratification.

Applications and Challenges

Use of seed for propagation of sedges and rushes would permit collection and storage of achenes and seeds of many species from a range of collection zones for later use. Availability of seed, container stock, and "sprigs" would add considerable flexibility to revegetation efforts.

Further work is required before the feasibility of propagating sedge and rush species from seed can be evaluated: (1) Equipment and technology developed for producing, harvesting, conditioning, propagating, and planting small-seeded grass and forb species should be evaluated for use with sedges and rushes. (2) Additional studies must be conducted to provide guidelines for relieving dormancy and maximizing germination of individual species. (3) Propagation practices for producing container stock of individual species from seed or vegetative material must be developed. (4) Techniques and equipment for preparing seedbeds and planting sites and planting seedlings on highly varied riparian and wetland sites are needed. (5) Direct seeding will require techniques for evenly distributing the small achenes and seeds. Pretreatments preparing the achenes and seeds for rapid germination on mist surfaces would permit spring seeding when danger of flooding is past.

For further information contact the authors at 208-334-1457 or Intermountain Research Station, Forest Service, U.S. Department of Agriculture, 316 E. Myrtle, Boise, Idaho 83702.

Hurd, E.M., and N.L. Shaw. 1992. Development of seed technology for Carex and Juncus species of the Intermountain Region. In: T.D. Landis (compiler). Proc. Intermountain Forest Nursery Association 1991 Annual Meeting; 12-16 Aug. 1991; Park City, Utah; USDA Forest Serv. Gen. Tech. Rep. RM-. {In Press}.

Johnson, W.M., J.O Blankenship, and G.R. Bram. 1965. Exploration in the germination of sedges. USDA Forest Serv. Res. Note RM-51.

Table 1.–Species included in seed propagation studies.

Sedges	
Species	***Common Name***
Carex amplifolia	Big-leaf sedge
Carex aquatilis	Water sedge
Carex douglasii	Douglas sedge
Carex Lanuginosa	Woolly sedge
Carex lenticularis	Lens sedge
Carex microptera	Small-winged sedge
Carex nebrascensis	Nebraska sedge
Carex pachystachya	Chamisso sedge
Carex praegracilis	Silver sedge
Carex rostrata	Beaked sedge
Carex sheldonii	Sheldon's sedge
Carex simulata	Shortbeaked sedge
Carex stipata	Prickly sedge
Carex subfusca	Rusty sedge
Carex vesicaria	Blister sedge
Carex vulpinoidea	Fox sedge

Rushes	
Species	***Common Name***
Juncus articulatus	Jointed rush
Juncus balticus	Baltic rush
Juncus bufonius	Toad rush
Juncus effusus	Soft rush
Juncus ensifolius'	Dagger rush
Juncus howellii	Howell's rush
Juncus tenuis	Slender rushes
Juncus torreyi	Torrey's rush

Roadbed Stabilization

Douglas D. Basford, Forester, USDA Forest Service, Salmon National Forest, Salmon Ranger District, Salmon, Idaho

Past grass seeding practices on the Salmon Ranger District in the early 1970's were generally inconsistent and ineffective on revegetating newly constructed roads. Seeding usually occurred in October or November on frozen and snow covered roads. This method usually resulted in low survival rates except on the moist sites.

Steve Monson was contacted at the Intermountain Research Station at Boise, Idaho in the early 1970's for advice and consultation. The Salmon Ranger District then modified their seeding practices to incorporate the following:

(1) Apply seed and cover and/or mix with the soil by harrowing or covering with a chain drag system. This allowed germination and root growth to occur under the snow before it melted in the spring of the year. Adequate root growth and hardening off of the plant species would then occur before the drought period during July and August. This was a key element in increasing our survival rates to the 80 or 90 percent level.

(2) Seeding and harrowing needs to occur in late September or early October before the ground freezes. Harrowing or chaining to cover the seed has been ineffective when applied on frozen surfaces.

(3) Avoid seeding in the late spring or during the summer. Success rates are usually low due to inadequate root development and drought conditions that occur during the summer.

By following these criteria the success rate of our seedlings increased to approximately 90 percent on the road surfaces and road fillls. Equipment was tested on the cut slopes in the fall of 1991 and will be evaluated in 1992 as to its success rates.

Equipment presently being used consists of an electric seeder mounted in the back of a pickup. Seeding is done ahead of the chaining or harrowing operations. A chain system attached to an extention off the blade of a road grader is used for the cut slopes. Part of the same basic chain system is also used for the fill slopes except it is attached to an extention mounted to the bumper of the pickup doing the seeding. This pickup is also used to pull the English Harrow to cover the seed on the road surface.

The cost of the equipment for this type of seeding operation is approximately $1000 to $1200. Estimated production rates are four to six miles per day.

Approximately 24 pounds of seed per acre were applied to the road surface. The seed mix used during the seeding operations consisted of the following species: (1) Timothy, (2) Intermediate Wheatgrass (3) Slender Wheatgrass (4) Southern Smooth Brome (5) Smooth Brome (Manchar) (6) Potomac Orchard Grass and (7) Mountain Brome (Bromar).

Field testing over the last 10 to 15 years indicates that this method has a high success rate if the above guidelines are followed. It is a cheap and economical method of revegetating disturbed areas and is easily adapted to the equipment found on any road construction project.

Seedbed Preparation In Cheatgrass Infested Rangelands

Milke Pellant and Mike Boltz, Range Conservationists, USDI Bureau of Land Management, Idaho State Office and Boise District, respectively, Boise, Idaho

Cheatgrass (*Bromus tectorum*), an introduced annual grass, dominates over 2 million acres of rangelands administered by the Bureau of Land Management (BLM) in southern Idaho. The BLM has initiated a greenstripping program using fire resistant vegetation to reduce the spread of wildfires on cheatgrass infested rangelands. Rehabilitation efforts on burned rangelands are also hindered where cheatgrass was common prior to the wildfire. Mechanical treatments are commonly used to reduce cheatgrass competition prior to the seeding process.

Disk Chain

The disk chain, and its modifications, used by Idaho BLM have been previously described (Pellant 1988 and Pellant 1990). The disk chain is a "one-pass" piece of equipment that prepares the seedbed and distributes seed over a 35 foot area. Monitoring studies have been established to document cheatgrass control on projects treated with the disk chain. The following recommendations are based on these studies:

1. Burning the surface litter and standing dead prior to operation of the disk chain improves cheatgrass control and seeding success.

2. Operation of the disk chain in the fall, the recommended time to plant, is ineffective if cheatgrass germination has not occurred. Cheatgrass density is often greater in the treated than in the untreated area if the disk chain is used in dry fall months.

3. Operation of the disk chain on moist, loam and silt loam soils enhances surface crusting, reducing establishment of seeded species. Use of the disk chain should be carefully monitored on moist soils.

4. Small seeds may be buried too deeply if dropped in front of the disk chain. Better establishment was observed when small seeds were placed behind the disk chain and covered with a light chain.

The disk chain is a cost effective and sound technique to reduce cheatgrass prior to seeding perennial vegetation. However, soil moisture, surface litter, cheatgrass phenology and seed size, all must be considered prior to making a decision to use the disk chain.

Plow and Seed

The Boise District has used Towner and wheatland plows to create greenstrips in areas still dominated by big sagebrush where firebreaks would enhance fire suppression capabilities. Removal of big sagebrush from the greenstrips is necessary to keep flame lengths short and close to the ground.

The greenstrips have of necessity traversed sites with differing levels of potential annual competition to seeded species, and have afforded an opportunity to evaluate the interaction of plowing treatments with site, pre-treatment vegetation, and season. Monitoring studies on these projects have revealed that:

1. Cheatgrass control in the seedling year is correlated with pre-treatment levels. Old, unrehabilitated burns which are dominated by annuals have high cheatgrass competition to seeded species; sagebrush communities with primarily bare ground or perennials in the understory have low levels of cheatgrass competition for a given season of plowing.

2. The season of plowing has a strong influence upon cheatgrass control. Summer plowing and fall plowing where no germination has occurred is ineffective for cheatgrass control because it relies too heavily on near-complete seed burial. Stones and surface litter tend to interfere with complete burial. Spring plowing is more effective because it generally kills the living plants. The more thorough the germination, the more effective the control.

3. Effective control of annual and perennial grass competition appears to be more important than sagebrush control to initial seeding establishment.

4. Sagebrush control with once-over plowing appears to be most effective in summer when soils are dry, sagebrush stems are brittle, and before sagebrush seed becomes viable. Early fall plowing may be equally effective if these conditions are met. Late fall or early spring plowing, particularly if the soils are moist, wet, or frozen appears less effective. In addition, late fall plowing plants viable sagebrush seed in a favorable seedbed.

5. Fire suppresses big sagebrush to a much greater degree than once-over plowing. Effective protection from fire is a necessary precondition for maintenance of big sagebrush in the successional patterns in the 8 to 12 inch precipitation zone in southwest Idaho.

6. Crested wheatgrass seedling density is influenced by:

- Pretreatment cheatgrass levels
- Season of planting
- Reseeding equipment

a. Ineffective fallow on sites with high pretreatment cheatgrass levels results in seeding failure. Sites with low pretreatment cheatgrass levels allow more latitude in timing and equipment used for treatment.

b. Fall planting has more consistent success and is less vulnerable to spring drought than spring planting.

c. Broadcasting with adequate seed coverage yields far higher seedling densities than drilling with depth bands for a given application rate. Tire drags and a vine roller cultipacker were used to cover the broadcast seed. Cultipacking action varied from nil in powder dry soils to high in moist to wet soils.

7. Alfalfa seedling density appears very sensitive to annual grass competition. Densities tended to be higher with broadcast planting than with rangeland drills if seed coverage was provided. Aerial broadcast of alfalfa without seed coverage has generally yielded disappointing results compared to rangeland drills. There was some tendency to have higher alfalfa densities for spring plantings.

Literature Cited

Pellant, Mike. 1988. Use of disk chain on southern Idaho's annual rangeland. In: Vegetation Rehabilitation and Equipment Workshop: 42nd Annual Report, Corpus Christi, TX,

Pellant, Mike. 1991. Rehabilitation equipment development in southern Idaho. Rangeland Technology Equipment Council: 1991 Report, Reno, NV.

Soil Bacteria For Weed Control

A.C. Kennedy, USDA Agricultural Research Service, Pullman, Washington

Annual weeds are a problem in range establishment. Downy brome (*Bromus tectorum L.*), commonly called cheatgrass, infests 5.7 million hectares in the western United States. Downy brome, an invader species from Eurasia, will germinate in fall or spring over wide ranges of temperature and moisture. It often is considered an important forage species providing early spring grazing; however, its short growth period, fluctuating forage production and high fire hazard make it less desirable than other species. Downy brome is an effective competitor for space, water, and nutrients because its roots continue to grow at low temperatures. The accumulation of downy brome root mass in the late fall through early spring allows it to be more competitive than other plant species. Perennial grass seedlings often fail because downy brome is so competitive.

Rhizosphere microorganisms often negatively influence plant growth. Manipulation of the plant root microflora to enhance selective plant antagonists may alter competition among range plants. Phytotoxic effects of microorganisms can be plant species and cultivar specific. Plant-suppressive bacteria potentially may be used to regulate the growth of unwanted plant species growing simultaneously with more desirable plants. This would be especially true if competitive weed growth coincided with environmental factors conducive to bacterial growth and production of weed-suppressive activity. Downy brome is an excellent weed species for this type of investigation.

Biological control offers a novel, alternative means of suppressing weed growth and establishment. We have isolated soil bacteria that are selective in their root growth suppression of various grass weed species. These naturally-occurring soil bacteria suppress plant growth by the production of plant-suppressive compounds. These bacteria are excellent biological control agents because they are aggressive colonizers of the roots and residue. The bacteria can function as a direct delivery system for the natural "herbicide" they produce. Most of the bacteria we studied inhibited root growth, although some bacteria inhibit seed germination. These inhibitory bacteria cause the greatest reduction in weed growth at low temperatures. They are most prevalent in the soil in late fall and early spring. Application of these bacteria during seed bed preparation and the resultant suppression of downy brome root growth may allow other plant species to out-compete the downy brome, thus leading to the establishment of more desirable range species.

Field studies were conducted in eastern Washington to evaluate the effect of the inhibitory bacteria on the growth of downy brome. In seeding field trials, in which downy brome was planted in rows, bacterial isolates reduced downy brome populations up to 30% and shoot dry weight up to 42%. In other studies, bacteria were applied to wheat fields infested with natural populations of downy brome. Downy brome and winter wheat growth and development were measured throughout the growing season. Reduction in downy brome growth varied and was dependent upon the specific bacterial strain. One strain of inhibitory bacteria reduced plant populations and above ground growth of downy brome 31 to 53%, respectively. In the same experiment, seed production of downy brome was reduced 64%. Winter wheat yields were increased by 35% with the application of the bacteria and subsequent suppression of downy brome growth. This increase in yield is similar to the yield increase expected from the elimination of a moderate infestation of downy brome.

Thus far, field studies along with laboratory and greenhouse studies have illustrated the ability of inhibitory bacteria to suppress the growth of grass weeds. This research demonstrates the use of plant-suppressive bacteria as biological control agents for grass weeds. Research into methods of application, such as, surface application, applications with straw residue or clay particles, and seed bacterization is continuing.

For further information, contact Ann C. Kennedy, USDA-ARWS, 2154 Johnson Hall, Washington State University, Pullman, WA 99164-6421, (509) 335-1554.

Sagebrush Establishment Enhanced By Snowfencing

Stephen B. Monsen, Susan E. Meyer, and Stephanie L. Carlson, Botanists, USDA Forest Service Shrub Sciences Laboratory, Provo, Utah

Introduction

Mine reclamation plans often call for re-establishment of native shrub species as well as perennial grasses and forbs. Many factors contribute to poor seeding success with shrubs, including incorrect planting methods, use of poorly adapted ecotypes, and failure to control competition from weeds and other seeded species.

One factor in seeding success commonly considered beyond control is the weather. Especially on semiarid sites, a dry

winter can result in failure of even the best-planned seeding. This problem is most acute for small-seeded surface-emerging species like sagebrush.

Natural recruitment in sagebrush stands often occurs even in marginal years. This indicates that adult plants act to ameliorate seedling microenvironment by trapping snow, thereby extending the period of favorable surface moisture later into the spring. Cooperative studies were established with mines in four western states to test the hypothesis that snow harvesting would enhance sagebrush emergence and establishment, especially in marginal years.

Objectives

1. To test the effectiveness of snow harvesting in enhancing sagebrush seedling emergence and establishment at four contrasting western mine sites.

2. To compare the effectiveness of snow fence and straw mulch, alone and in combination, as snow harvesting techniques.

3. To relate the effectiveness of snow harvesting treatments to weather conditions at each mine site.

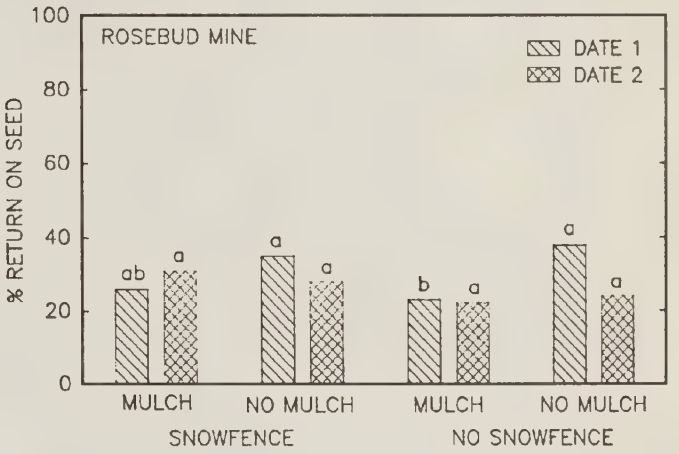
Methods

Experiments were established in autumn 1988, using similar plot layouts at all four sites. The sites were prepared by ripping, topsoiling, disking, and harrowing to provide a firm seedbed. Snowfence was then erected, and straw was crimped in for the mulch treatments. Plots were seeded by broadcasting with a uniform seeding rate of approximately 50 seeds (P.L.S.)/square foot. The seed source for each site was a locally adapted species and ecotype.

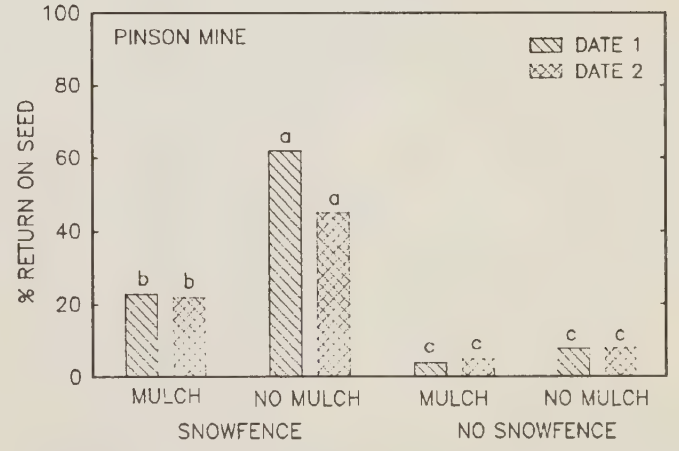
Plot evaluation took place approximately two weeds after spring snow melt-off at each site, and again in mid to late summer. For each 10 X 10 foot plot, all sagebrush seedlings within three 10 x 1 foot strips (30% of total area) were enumerated using a one foot square sampling frame.

Results were analyzed for each site using appropriate analysis of variance techniques. The least significant difference test was used for means separation ($P<0.05$). Seedling counts were converted to a return-on-seed basis (seedling/seeds sown) for graphic representation.

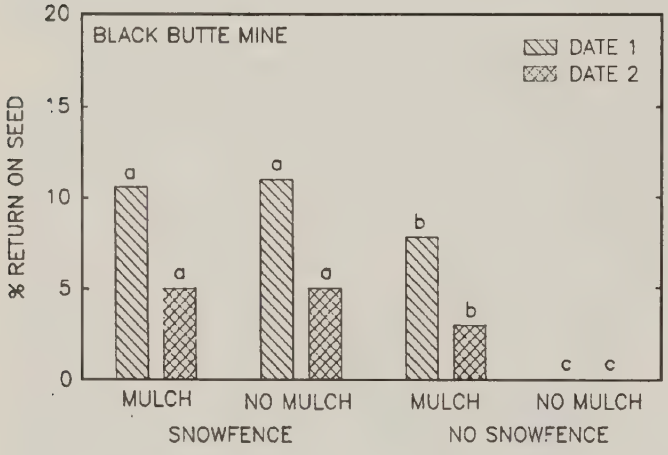
Results



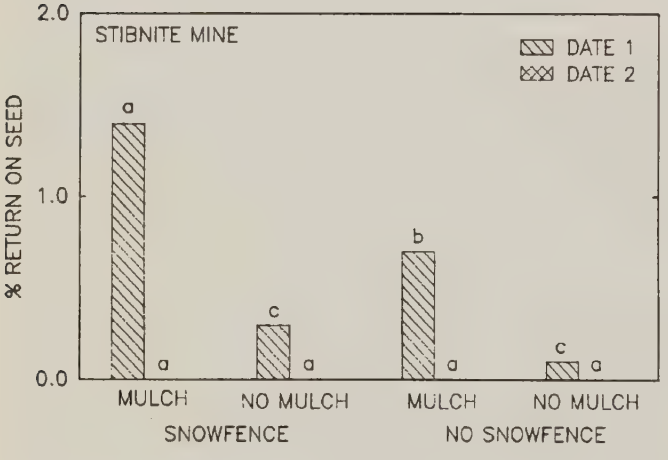
At the Rosebud Mine, in northern Montana, above-average winter moisture resulted in excellent emergence and survival regardless of snow harvesting treatment. In this kind of year, snow harvesting produces no net increase in recruitment.



At the Pinson Mine, near Winnemucca, Nevada, an average moisture year provided enough winter snow cover in the snow fence treatment to produce six times as many established seedlings as the no snow fence treatment. Straw mulch had a negative effect. Even the control treatment gave adequate return on seed.



At the Black Butte Mine, near Rock Springs, Wyoming, a marginal moisture year gave lower return on seed than at Pinson or Colstrip, with no observed emergence in the eh control treatment. Both snow fence and straw mulch significantly improved sagebrush seedling establishment.



At the Stibnite Mine, at high elevation location near Stibnite, Idaho, observed emergence was minimal, possibly due to killing frost after snowmelt. A combination of snow fence and straw mulch resulted in significantly higher emergence. No living seedlings were noted on the second sampling date.

Conclusion

Results of this study indicate that snow harvesting techniques would be used effectively to enhance establishment of sagebrush species on mine disturbances in marginal moisture years. Small scale snow harvesting combined with intensive shrub seeding could be used to establish shrub patches that serve as centers for continued natural recruitment. These patches could be seeded without competition from aggressive perennial grasses.

Snow harvesting was effectively achieved using a four foot snow fence, which is costly and slow to establish. Modification of mechanical fencing equipment would likely increase the utility of existing machinery to construct small catchment fences. The system would be economically feasible on mine disturbance and other wildland sites. Other techniques may be used to harvest snow, including creation of deep furrows or soil mounds. Equipment is needed to construct and erect small snow catchment structures for treatment of barren surfaces.

Integrated Weed Management

Barbra Mullin, Weed Coordinator, Montana Department of Agriculture, Helena, Montana

Integrated Weed Management has been defined in a variety of ways. One definition is "a management system that uses all suitable methods in a compatible manner to reduce weed population to levels below those causing acceptable economic or ecological consequences." The key here is the use of all suitable methods. It is an ecological approach to managing unwanted plant species.

To correctly utilize an integrated approach it is important to assess all factors prior to making a decision: target weed, size of infestation, non-target vegetation, soil types, climatic conditions, important water resources. It is also important to understand the weed management objectives for the area: different land managers and agencies have different goals and restrictions on their activities, which will impact the final management decision.

There are many different techniques to be considered in developing an effective management plan. They include:

Prevention: The cheapest weed control is preventing establishment in the first place - quarantines, weed-free hay programs, and certification of agronomic crops are all examples.

Education: Field staff should be familiar with weeds found in the area as well as potential threats to the area. Staff training is critical. Educating the general public is also important — what weeds are of concern and why they are a threat.

Cultural: The use of plant competition and mulches to keep weed competition to a minimum can be used but generally works best with annuals.

Mechanical: The use of a physical method to eliminate the weed can be effective on small infestations. Handpulling, hoeing, and mowing are methods used. This is generally an expensive treatment.

Biological: When using a living organism to manage a specific weed we traditionally think of insects. Other tools include plant pathogens and grazing animals. Biocontrol methods generally will suppress host weed populations, but not contain or eradicate them.

Chemical: Herbicides can also be used to control unwanted vegetation. There are important licensing requirements and environmental concerns when using herbicides. It is critical to follow all label and site directions.

To make IWM work it is important to understand all of the methods available for use; evaluate the site and choices for restrictions and then take action. A systems approach to weed management, with increased emphasis on managing the land for beneficial species and specific controls targeting unwanted vegetation, is the ultimate goal of integrated weed management.

For further information, contact the author at: MDA, Capitol Station, Helena, Montana 59620, Telephone: (406) 444-2944.

Montana Noxious Weed Seed Free Hay

Larry Hoffman, Lewis and Clark County Extension Agent, Montana State University Extension Service, Helena, Montana

Purpose:

The purpose of the Montana Noxious Weed Seed Free Hay program is to provide forage free of designated noxious weed seeds for the feeding of livestock on private and/or publicly owned lands.

State of Montana Category I, Category II and Category III noxious weeds are a "must" in the certification of "Noxious Weed Seed Free Hay".

Category I	Category II	Category III
Canadian Thistle	Dyers Woad	Yellow Starthistle
Field Bindweed	Purple Loosestrife	Common Crupina
Whitetop	Sulphur Cinquefoil	Rush Skeleton Weed
Leafy Spurge		
Russian Knapweed		
Spotted Knapweed		
Diffuse Knapweed		
Dalmation Toadflax		
St. Johnswort		

Other noxious weeds listed below "must" be verified but may not disqualify the crop. Disqualification is a judgment made by the inspector following the County Weed Districts' policy for the county where the inspection is done.

Other:

- Baby Breath
- Burdock
- Caroway
- Downy Brome or Cheatgrass
- Common Tansy
- Common Mullein
- Cypress Spurge
- Halogeton
- Black Henbane or Henbane
- Houndstongue
- Lettuce - blue
  - prickly
- Musk Thistle
- Oxeye Daisy
- Perennial Sowthistle
- Poison Hemlock
- Purple Mustard
- Quackgrass
- Showy Milkweed
- Tansy Ragwort
- Tall Buttercup
- Tall Larkspur
- Toadfloax - common
  - yellow
- Wild Licorice

The Montana Noxious Weed Seed Free Hay program also provides an opportunity for the uninterrupted movement of forages into and through counties, states, or countries where regulations are placed on noxious weeds and/or where forages passing through or being brought in to an area require certification or other documentation certifying that the forage is free of noxious weed seeds.

Noxious Weed Seed Free Hay is a forage product that has been certified by an authorized inspector representing the County Extension Service or the Weed District.

Forage products that the MNWSFH program are working with at this time are: alfalfa hay, grass hay, alfalfa/grass hay, straw, grain hays and forage pellets/ cubes.

The program has not, at this point in the development, brought in hay quality. In the future, when general standards can be agreed on, the quality of hay will play a major part in marketing efforts.

Introduction:

Over the past 10 to 12 years, areas throughout Montana have been pushing for weed control management on a large scale basis. An area that has come up time and time again was for a statewide clean hay program to help manage and minimize the spread of noxious weeds. The Montana Noxious Weed Seed Free Hay program has met that challenge and has shown success and a need for noxious weed seed free forage.

The Montana Noxious Weed Seed Free Hay (MNWSFH) program has been functioning since 1989. The program has been administered by the Montana Extension Service, through the coordination and cooperation from Gene Surber, Gallatin County Extension Agent, and Larry Hoffman, Lewis and Clark County Extension Agent.

Figures showed an increasing interest for the programs in 1990 and then a leveling off in 1991 along with federal and state agency support and adjacent state and foreign inquiries to the MNWSFH program.

Hay Tonnage by Product:

Alfalfa - 3,118 tons
Alfalfa/grass - 7,185 tons
Other - 166 tons
Grass - 1,229 tons
Pellets - 64 tons
Straw - 225 tons

The Extension Service will continue to work with state and federal agencies, bordering states and provinces to promote MNWSFH education training of county representatives and administer the producer program until a financial base and authorized group can take on the responsibilities.

Statement Of Need:

MNWSFH is not based on a "problem" but as a solution to an ongoing problem - weed management.

Counties, states, provinces, and countries wishing to purchase Montana forage indicate a need for more "noxious weed seed free forage" to meet the intra- and interstate and international markets.

Private and public land (BLM, Forest Service, State Lands, FWP) managers are requesting higher standards of quality forage feed on their lands.

NWSFH needs time to organize sufficiently to promote and market noxious weed free seed forage effectively.

Specific Objectives: Standards of MNWSFH have been established as a support mechanism for weed management in forage production and for possible marketing

	1989	1990	1991
Counties in Program	13	23	35
Counties with Representatives	24	45	35
Number of Representatives	38	59	49
Producers	77	143	126
Acres - Inspected - Certified	3,386 2,536	12,953 11,156	6,321 5,935
Tonnage Certified For Sale	5,116	16,637	11,987

opportunities. Phase II of the MNWSFH program will continue efforts to broaden its scope and success by:

1) Developing a producer organization and board.
2) Coordinating a statewide forage organization.
3) Continuing to expand the MNWSFH program and strengthen policy acceptance with state and federal agencies for public lands.
4) Coordinating and promoting regional noxious weed seed free forage efforts.

The MNWSFH program will continue to:

1) Strengthen a uniform statewide project.
2) Continue to initiate policy.
3) Train county representatives.
4) Administer the program.
5) Educate producers and purchasers on the importance of MNWSFH.
6) Produce and distribute MNWSFH information, publications, etc.

A Weed Trust Grant, awarded in 1989, estimated that the MNWSFH program would take five years to become self supporting and sustaining. The program is now 3 years old.

The program is gaining merit, State and Regional recognition and is providing a weed free quality product for state, interstate and international markets.

The second phase of the MNWSFH program is to strengthen original objectives and promote a regional concept.

Regional Concept:

- 12 State Program
- Objectives:

  Standardize

  - *Inspection and Certification Policy*
  - *Inspection procedures*
  - *Form standardization*
  - *Wildlife poster promotion*
  - *Transfer standards*
  - *Marketing the product*
  - *Training standardization*
  - *Quality Standards*

Biological Control of Spotted Knapweed and Leafy Spurge: Principles and Prospects

Jim M. Story, Montana State University, Western Agricultural Research Center, 580 Quast Ln., Corvallis, MT 59828

The existing methods of weed control, namely chemical, cultural and mechanical, are not providing adequate solutions to the control of many rangeland weeds in Montana and other areas of the Pacific Northwest as evidenced by the steady increase in weed-infested acreage on rangeland. In Montana alone, spotted knapweed, first reported in the state in 1927, now infests an estimated 4 million acres of rangeland, while leafy spurge, first reported in the state in 1923, now occupies an estimated 550,000 acres. Vast areas of the Pacific Northwest are threatened by these and other weed species.

A major reason for the rapid spread of these weeds is that the plants are introduced species and therefore lack the complex of natural enemies that effectively regulate their densities in their native area of eastern Europe. In view of this, Montana State University, in cooperation with USDA-APHIS, and USDA-ARS, has established a program which seeks to fill these natural enemy voids with Eurasian-collected organisms proven to be host-specific to the respective target weeds. This approach, known as biological control is rapidly gaining public support.

Biological control is particularly attractive because it is permanent, very selective, energy self-sufficient, comparatively economical, and environmentally safe since no toxic substances are introduced into the environment. However, biological control is not without its limitations:

1. It is a slow process and therefore not an immediate control.

2. It does not achieve eradication, but merely reduces densities to more tolerable levels.

3. It is often too selective; it will only attack one weed existing among a complex of other weeds.

4. It cannot be used against weeds which are valued under some situations since insects don't recognize boundaries.

5. It cannot be used against weeds that are closely related to beneficial plants as the insect may be unable to discriminate between the related plant species.

6. The use of insects against cropland weeds under intensive cropping practices is not feasible due to the elimination of the host weed.

To date, seven insect species (three flower head insects and four root insects) have been introduced against spotted knapweed in the U.S. Of these, five are established and increasing in numbers. The first U.S. releases of two new flower head insects will be made in the summer of 1992.

Eight insect species (six root insects, one stem insect, and one defoliator) have been introduced against leafy spurge. Seven of these insects are established. Additional insect species are currently being screened.

The obvious importance of biocontrol in the management of exotic weeds insures that biocontrol efforts will be expanding in the near future. However, as noted, biological control is not a "cure-all" and, therefore, cannot be looked upon as a replacement to herbicides. Successful management of our rangeland weeds will be a long-term effort involving the combined use of biocontrol and all other methods in an integrated approach.

For further information, contact the author at the above address or by phone: (406) 961-3025.

Noxious Weed Spraying Equipment (Abstract)

Fred Oligschlaeger, President, Spratronics, Inc., Bothell, Washington

1. *Operator Safety*
   - *Closed chemical loading*
   - *100% sprayer control from vehicle cab*
   - *Mid-ship mounted boomless spray head*
   - *Automatic Control of chemical application rates*
   - *Sprayer is flushed on site*

2. *Sprayer Features*
   - *Chemical injection control system*
   - *Water only in main tank, separate chemical tanks*
   - *Boomless spray head (single or dual)*
   - *9 foot wet boom (cover width of sprayer)*
   - *closed loading of chemicals*
   - *Printer & data logger (for record keeping)*
   - *Console displays*
     - . Acres sprayed
     - . Amount of chemical dispensed
     - . Application rate of each chemical
     - . Distance traveled
     - . Miles per hour
     - . Spray width

3. *Environmental Safety*
   - *Ultra low drift boomless spray head*
   - *Multi-channel chemical injection permits selective chemical spraying*
   - *Chemical application rates are constant regardless of ground speed or spray width sections.*
   - *Chemicals are contained in 15 or 30 gallon chemical tanks*
   - *7 section spray head*

4. *Sprayer Operator Productivity*
   - *Closed loading*
   - *Single pass spraying*
   - *Boomless spray head, 7 sections*
   - *Reduced spray clean-up time*
   - *Reduced spray calibration time*
   - *Chemical application rate change on the go*
   - *Printer Data logger for record keeping*

For further information, contact the author, Fred Oligschlaeger at (206) 338-0241, 15721 24th Drive SE, Bothell, WA 98012.

Simplex

Ken Glanz, Sales Representative, Simplex Manufacturing, Portland, Oregon

Simplex Manufacturing is a small, privately held corporation involved in the designing, fabrication and sales of aerial application equipment. The company dates back to the 1940's when the founder fabricated the first aluminum pumps for agricultural airplanes. From this beginning, Simplex has grown to be the largest supplier of equipment for helicopters and fixed wing aircraft in agriculture, forestry, firefighting and oil pollution control. Most of our early designs were for the Bell 47 and Hiller and were for wet application. During those years, Simplex developed the technology to build reliable equipment, spray booms for best pattern results, and how to vary flow rates for special projects. We have carried that technology into the 80's and 90's for larger aircraft, bigger systems and more technical controls.

Simplex systems provide a wide range of techniques from larviciding, low volume applications and ultra low volume applications with highly controlled droplet sizes. Our latest spray system is for spot spraying in forestry and for the drug enforcement agencies.

Today, with an increase in aerial application comes drift claims, higher insurance rates and environmental concerns,

which require more and more applicators to look towards a dry, granular application. Simplex followed that lead by developing precision seeding system, ultra low weight system where just several pounds are applied per acre, and the DDA system where several ounces per acre can be applied. This has greatly reduced drift claim problems, but requires a whole different technology in equipment.

At the other end of the spectrum, Simplex manufactures spreaders that are capable of application rates up to 5000 pounds per minute, which represents 100 pounds per acre.

Simplex lead the way in aerial ignition by introducing a gelled fuel igniter system known as the Heli-Torch and marketed the industry standard Sure Fire gelling agent. This equipment has been used extensively in fire fighting with fire for wildlife habitats, slash burning and other fire applications including the burning of spilled oil. To complement our aerial ignition line, Simplex developed ground support equipment, including our mix-transfer system, ground firing and other equipment to make the burning operation more efficient.

The most recent addition to our product line is Fire Attack, designed for most popular working helicopters. Fire Attack utilizes micro-processor controlled loading, discharge, foam injection and record keeping functions all designed to be easily operated by the pilot. Additional products which Simplex represents includes water handling systems manufactured by Griffith Polymers and Fireflex Manufacturing, flow meter and load cell systems by Onboard Systems, and tee jet spray accessories by Spraying Systems.

For more information, contact Ken Glanz, Sales Representative, Simplex Manufacturing, 13340 NE Whitaker Way, Portland, OR 97230

Attendance

Meeting			Participants				
Date	*Place*	*Presiding Chairman*	*Federal Gov't*	*State Gov't*	*Private*	*Foreign*	*Total*
Dec 1946	Portland[1]	Joseph F Pechanec	6	0	0	0	6
Dec 1947	Ogden[1]	" "	9	0	0	0	9
Jan 1949	Denver	" "	15	0	0	0	15
Dec 1949	Ogden[1]	" "	22	0	0	0	22
Jan 1951	Billings	" "	34	5	0	0	39
Jan 1952	Boise	A.C.Hull	45	9	0	0	54
Jan 1953	Albuquerque	" "	75	15	9	1	100
Jan 1954	Omaha	" "	63	8	3	5	79
Jan 1955	San Jose	W.W. Dresskell	62	10	4	1	77
Jan 1955	Denver	William D. Hurst	86	12	1	2	101
Jan 1957	Great Falls	" "	95	10	4	0	109
Jan 1958	Phoenix	Frank C. Curtis	87	9	3	0	99
Jan 1959	Tulsa	" "	84	5	2	0	91
Jan 1960	Portland	" "	98	10	3	3	114
Jan 1961	Salt Lake City	" "	123	11	14	2	150
Jan 1962	Corpus Christi	Frank Smith	58	5	7	1	71
Jan 1963	Rapid City	" "	52	6	1	0	59
Jan 1964	Wichita	John Forsman	61	10	5	0	76
Jan 1965	Las Vegas	" "	77	8	6	0	91
Feb 1966	New Orleans	" "	47	8	5	1	61
Feb 1967	Seattle	A. B. Evanko	58	10	4	0	72
Feb 1968	Albuquerque	" "	84	16	13	1	114
Feb 1969	Great Falls	" "	46	3	13	0	61
Feb 1970	Denver	" "	81	8	11	0	100
Feb 1971	Reno	" "	74	6	15	2	97
Feb 1972	Wash., D. C.	" "	48	3	6	0	57
Feb 1973	Boise	" "	60	7	7	4	78
Feb 1974	Tucson	Bill F. Currier	61	12	10	14	97
Feb 1975	El Paso[1]	Stan Tixier	49	9	11	1	70
Feb 1976	Omaha	" "	50	17	12	0	79
Feb 1977	Portland	Vern L. Thompson	63	26	31	10	130
Feb 1978	San Antonio	" "	68	26	35	6	135
Feb 1979	Casper	Ted Russell	74	35	72	12	193
Feb 1980	San Diego	" "	97	44	88	21	250
Feb 1981	Tulsa	" "	56	35	111	16	218
Feb 1982	Denver[1]	" "	60	18	68	5	151
Feb 1983	Albuquerque	" "	119	82	96	9	306
Feb 1984	Rapid City	Randall R. Hall	95	22	49	7	173
Feb 1985	Salt Lake City	" "	110	46	85	13	254
Feb 1986	Orlando	Gerald Henke	41	31	29	13	114
Feb 1987	Boise	" "	94	35	34	5	168
Feb 1988	Corpus Christi	" "	42	14	23	8	87
Feb 1989	Billings	" "	65	19	23	2	109
Feb 1990	Reno	" "	19	11	13	3	46
Feb 1991	Wash., DC	Steve Monsen	13	8	7	1	29
Feb 1992	Spokane	" "	32	17	15	10	74

[1] Meetling not in conjunction with Society for Range Management meeting.

*U.S. GOVERNMENT PRINTING OFFICE 1992-0-691-235/60001